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[OFFICIAL NOTICE.]

Seventeenth Annual Meeting, Michigan Gas Association.

MICHIGAN GAS ASSOCIATION,
OFFICE OF THE SECRETARY,
DETROIT, MICH, Sept. 9, 1908.

To the Members of the Michigan Gas Association: Had it occurred to you that there is one gas meeting, from which you can get better results than from any other, and that is the meeting held in your own State? Very frequently you come in contact with someone not already a member who should be. The meeting will be held in Kalamazoo, September 23, 24 and 25.

The success of our Association is dependent entirely upon members that attend our annual convention. The topics for discussion are of interest to every gas man, and we hope you will show your interest by coming to our meeting in Kalamazoo, and encourage others to attend.

Our programme this year includes an extremely interesting paper, prepared at the University of Michigan, on "Destructive Distillation of Coal at Low Temperatures;" a paper by Mr. G. W. McKee, of the Peoples Gas Light and Coke Company, Chicago, Ills., on "Industrial Gas Appliances;" a combination paper, by Mr. Jayne, of Detroit, "Distribution System" in Detroit; Mr. Seymour, of Grand Rapids, on the "Distribution System" in Grand Rapids; a paper by E. St. Elmo Lewis, Advertising Manager of the Burroughs Adding Machine Company, on "Advertising as it Affects a Public Service Corporation," not so much as to the kind, but advertising in a general sense; a paper by Clark R. Graves, of the New Business Department, Detroit, on "New Business;" "Labor Saving in Medium Size Gas Plants," by F. G. Remington, General Superintendent, Battle Creek.

On Wednesday there will be an informal dinner at the Burdick House, which will be included in the entertainment ticket. On Thursday night there will be a complimentary theater party. The headquarters will be at the Burdick House, and we have arranged for accommodations as follows:

Rooms with bath.....	$3.50,	$4.00 and	$4.50	American.
" " "	2.00,	2.50	" 3.50	European.
" without bath	2.50,	3.00	" 3.50	American.
" " "	1.50,	2.00	" 2.50	European.

Reservation should be made in advance to insure the best.

There is also the Rickman (new) American plan, and the American Plan Hotel, with rooms $3 per day with bath, and rooms without bath $2 and $2.50 per day. Meetings will be held in the rooms of the Commercial Club, one block from the hotel. There will be plenty of room, and this is a mighty good place for the meeting. The rooms on the floor above will be used for appliance display.

If there is any change to be made in your name or address, please notify the Secretary immediately, so that it will appear properly in the next edition of the list of members. If there are any new names to be handed in, we shall be glad to have them at as early a date as is possible so that their names may appear in our list.

Kalamazoo is known as the home of several gas arc lamp factories, large paper mills and the greatest producing celery county in the State. Kalamazoo has a population of 40,000 and has more gas arc lamps than any city of its size in the world. Its enormous output per capita is of interest to manufacturers, its progressive new business department will interest every new business man in the State. It is an attractive city and has ample entertainments for those seeking such. Aside from all these inducements you will meet a number of fellow gas men in Michigan, getting acquainted with men who can interest you.

Whether you do or do not attend other gas meetings during the year, we believe that you are making a mistake is you do not come to Kalamazoo and join with us in making the 17th annual convention of the Michigan Gas Association a success. Yours respectfully,

ALONZO P. EWING, Secretary and Treasurer.

[OFFICIAL NOTICE.]

Annual Meeting, Empire State Gas and Electric Association.

EMPIRE STATE AND ELECTRIC ASSOCIATION,
OFFICE OF THE SECRETARY,
154 Nassau street, N. Y., September 1, 1908.

Gentlemen: The annual meeting of this Association will be held in the United Engineering Societies Building, 29 West 39th street, October 7, 1908. Among the subjects to be discussed are: "Public Policy Work of the Association." "Standards for Gas Service and Standards for Electric Service, Taking as a Basis the Recent Rules of the Railroad Commission of Wisconsin." "Taxation of Gas and Electric Companies in New York State with a Report from the Taxation Committee." "Insurance of Gas and Electric Stations." "Review

of the Decisions of the Public Service Commissions." "Electric Meter Testing with Report of the Meter Committee." "Accounting, with Report of the Accounting Committee." "Amendments to the Constitution and By-laws with a New Schedule of Annual Dues." "Affiliation with the American Gas Institute and the National Electric Light Association."

All of the details of the programme have not been completed, but it is expected that the meeting will be exceptionally interesting.

Truly Yours, CHARLES H. B. CHAPIN, Secretary.

BRIEFLY TOLD.

SIXTEENTH ANNUAL CONVENTION, PACIFIC COAST GAS ASSOCIATION.—The Sixteenth Annual Meeting of the Pacific Coast Gas Association was held, according to programme, at Santa Cruz, Cal., on the 15th, 16th and 17th insts. Our advices respecting the actual proceedings are at this time (18th inst.) so meager that we are unable to publish anything like a sequential story respecting it. However, enough is known to say positively that the meeting was in all respects a success. The technical programme included an excellent presidential message by Mr. C. O. G. Miller, and these papers at least:

"The High Pressure System of the Los Angeles Gas and Electric Company," by Mr. C. A. Luckenbach.
"The Story of Carbon Oil Gas Manufacture." by Mr. F. C. Willard.
"The Humorous Side of a Gas Man's Life," by Mr. W. H. Foster.
"Modern Methods of Heating," by Mr. H. R. Basford.

The story of Mr. Luckenbach was most interesting, and Mr. Foster's recital was all to the risible. The social side of the convention was most enjoyable in all respects, and its direction was flawless—it certainly should be when it is noted that such a veteran as John A. Britton was in charge of the Sec.-Treas.' desk. The local gas and electric lighting men—perhaps we might better say the local lighting men—were at once hosts and guests, a combination that makes unfraternity impossible.

[Since this was written the titles of the missing papers have come to hand. These were: "Corporation Regulation," by Mr. John A. Britton; and "Purification Problems," by Mr. Chas. F. Adams. The banquet at the Casino, the evening of the 16th inst., was simply a perfect entertainment, and a fittingly beautiful postlude thereto was the outing the following day.—EDS.]

The American Practice of Gas Piping and Gas Lighting in Buildings.

[Reviewed for the JOURNAL by "O."]

A book with the above title, by Wm. Paul Gerhard, C.E. (McGraw Publishing Co.), has been recently published, and the author, who is a consulting engineer for hydraulic and sanitary works and member of several societies, states that it "Is intended chiefly for the use and enlightenment of the gas consumer and householder."

It is 306 pages between covers, and is divided into 27 chapters, the principal subjects of which are: The predjudices against the use of gas; the advantages of gas, the arrangement of piping, burners, fixtures, etc.; dangers of gas leakage, and some historical notes, including a bibliography.

The author has presented the case of the gas companies in a most favorable light, in the chapters covering the popular side of the business, and many of the numerous fallacies are answered in a most telling manner.

In comparing the cost (Chap. III.) of gas versus electricity, neither the most efficient of either gas or electric lamps have been used, but the figures are fair to both, as far as the majority of installations may be concerned, and showing in the main a wide margin in favor of gas. In a later chapter (page 228) a statement is made, however, which does not coincide with these figures: "Owing to their efficiency, gas mantle burners are in some cases successful rivals to the electric lamp."

The advantages of gas for heat and power (Chap. IV.) are confined to a general statement covering ranges, water heaters, heaters and engines, and the consumer would hardly be able to make an intelligent selection from the advice given.

The efficiency of water heaters has undoubtedly been greatly improved in recent years; but the statement that "Enough hot water can be heated for a bath in about 30 minutes with a gas consumption of about 7.5 cubic feet" should be modified by an avowal that it would be a very small bath.

The portion of the book covering gas piping is undoubtedly the best (Chap. V.), but curiously enough this is incidentally the portion of the subject which has had the better care and attention in the past, and as proof of this the author remarks, "In former years the gas companies used to give much more attention to this matter than at present."

The standards of illumination have changed since the time when the various companies lessened their attentions to the matter of piping, so that we may expect to see renewed activity among them as the difference in cost between gas and electricity becomes smaller.

The specifications for piping (Chap. VI.) are very complete, and particular importance is given to a matter that is often neglected, namely, tests both before and after fixtures have been installed. The company which does not insist upon these tests is pursuing a very short-sighted and harmful policy. The author recommends the use of galvanized pipe, to which gas engineers will take exception, and also the method of describing the sizes of pipe by the use of decimals and not fractions. The rules, tables and regulations of gas companies and building departments are given in abundance in Chap. VII., and cover no less than 37 pages. In these is an extract, from a paper[1] by Mr. J. M. Robb, read before the Ohio Gas Light Association, March, 1906. A copy of this paper should occupy a prominent place in the distribution department of every gas company.

Piping for natural gas, gasoline gas and acetylene are covered in Chapter VIII., IX. and X., and the author again lays stress upon the matter of testing pipes by devoting a whole chapter (XI.) to that subject.

Although the use of artificial gas has passed its centennial of years, the consumer for whom this work is intended knows but little of its proper use as an illuminant. The author calls attention to this fact in the lamentably short Chapter (XII.) devoted to gas light illumination, but advises those interested to purchase another treatise which covers the subject more fully!

Should the public select their gas burners according to the space devoted by the author to the several styles in Chap. XIII., the sales of the open flame and regenerative would far outnumber those of the mantle type, which fortunately is not the case.

The real important features of mantle burners, such as regulation of both gas and air supply and the proper accessories, globes, shades, etc., are not mentioned, although a later chapter (XV.) contains nearly five pages upon globes and globe holders for open flame lamps. The chapter following, which covers the subject of gas fixtures, is a scathing denunciation of our fixture manufacturers.

"Firms engaged in the manufacture of fixtures often employ artists at a high salary to design novel forms of expensive, ornamental gas fixtures, but who has ever heard of a firm engaging a competent mechanical expert, or an "illuminating engineer" to make details for the mechanical execution of the work, and to advise on the best kind of burners and globes to be used?"

In Chap. XIV., on gas pressure regulation, the author makes some statements which will hardly receive the approval of gas engineers. For instance: "A pressure of 5-tenths at the burner is about right for flat flame and argand burners, while incandescent burners require a little higher pressure." Yes; nearly four times this amount is necessary in order to obtain the highest efficiency.

A later statement is also open for criticism on the same score: "In a town of small extent, with absolutely level districts, and with centrally located gas works, a gas pressure of 10-tenths inches of water in the mains would be ample to supply all consumers."

The most important chapter of all, which covers the illumination of interiors (XVIII.) deserves much praise, and it is to be hoped that it will reach many of our architects, for we must look to them to see to it that the realy essential details are carried out in future installations. There is one feature, however, which seems somewhat short-sighted, and that is the recommendation for the use of open flame burners instead of those of the mantle type.

The concluding chapter, which should prove of interest to the consumer, is called practical hints for gas consumers, but one very important feature of interior illumination is merely mentioned, and that is that the eyes should be protected from the direct rays of light.

A considerable portion of the book is devoted to matters which should be of interest to those connected with the gas business; such as gas pressure regulation, gas meters and gas meter stories; the relation between gas companies and gas consumers, accidents with gas and dangers to the public health.

The final chapters are reserved for some historical notes and a bibliography, and these latter comprise a very valuable contribution to gas literature.

The author has succeeded in presenting a technical subject in a very readable manner and brings forward a mass of facts which should kindle an interest to the benefit alike of company and consumer.

1. See JOURNAL, June 11, 1906, pp. 1016-21.

Some Well-known Photometrical Laboratories.[1]

By Dr. Edward P. Hyde.

1. *Photometry at the United States Bureau of Standards.*—On July 1, 1901, in accordance with an Act of Congress passed the preceding March, the Bureau of Standards was established to supersede the old office of Standard Weights and Measures, which prior to that time, in a restricted way had performed the functions of a national standards laboratory. By the terms of the Act the functions of the new Bureau were to "consist in the custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the Government; the construction, when necessary, of standards, their multiples and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials, when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere."

From a humble beginning, with a personnel of 14 men, and with temporary quarters in the buildings of the Coast and Geodetic Survey, the Bureau of Standards has developed into an institution with a force of 110 employees, and occupying three new laboratory buildings situated on a 7½-acre tract in the northwestern suburbs of Washington.

The work in photometry was inaugurated in the autumn of 1902 in one of the basement rooms of the Coast and Geodetic Survey building. For nearly 2 years it engaged the attention of only a single laboratory assistant; but in the spring of 1904 the photometric section moved to more commodious quarters in the new Mechanical Laboratory, and since that time the growth has been more rapid. At present the work is carried on by an associate physicist, two assistant physicists, a laboratory assistant and a laboratory apprentice.

Equipment.—The photometric equipment consists of one standard photometer, one Matthews integrating photometer, one commercial photometer, one spectrophotometer and various auxiliary photometric and electric apparatus, which will be described briefly in the following paragraphs.

The apparatus is mounted at present in 2 rooms 9 × 6 × 3.7 meters, and 4.8 × 4.8 × 3.7 meters respectively, but recently a third room 8 × 5.5 × 3.7 meters has been assigned to photometric work. A special feature of all of the laboratory rooms is the provision that has been made for a partial control of the humidity. Each laboratory is provided with a coil of pipe through which cooled brine is made to flow, and by passing the air of the room over this brine coil by means of a fan, the humidity can be reduced greatly.

The Standard Photometer Bench (Fig. 1) is used in all work on standard lamps, and in the investigation of special problems. The photograph from which Fig. 1 is made was taken when the bench was set up for the investigation of Talbot's law, in which Nernst glowers, covered by cylindrical hoods, were used as sources. One of the hoods is shown in position; the other is sitting on the table beside the bare filament.

The bench is of the Reichsantalt pattern, supplied with a Lummer-Brodhun contrast screen. By the use of a sufficient number of diaphragms, covered with black velvet and suitably placed, stray light is excluded to such an extent that the leakage of light into the photometer screen is entirely negligible, although the walls of the room are of a light color. The comparison lamp, on the right, is mounted on a carriage which is connected by means of adjustable links to the carriage supporting the photometer screen. The comparison lamp thus moves with the screen, remaining at a constant distance from it, so that the illumination on the right side of the screen remains constant during a series of measurements.

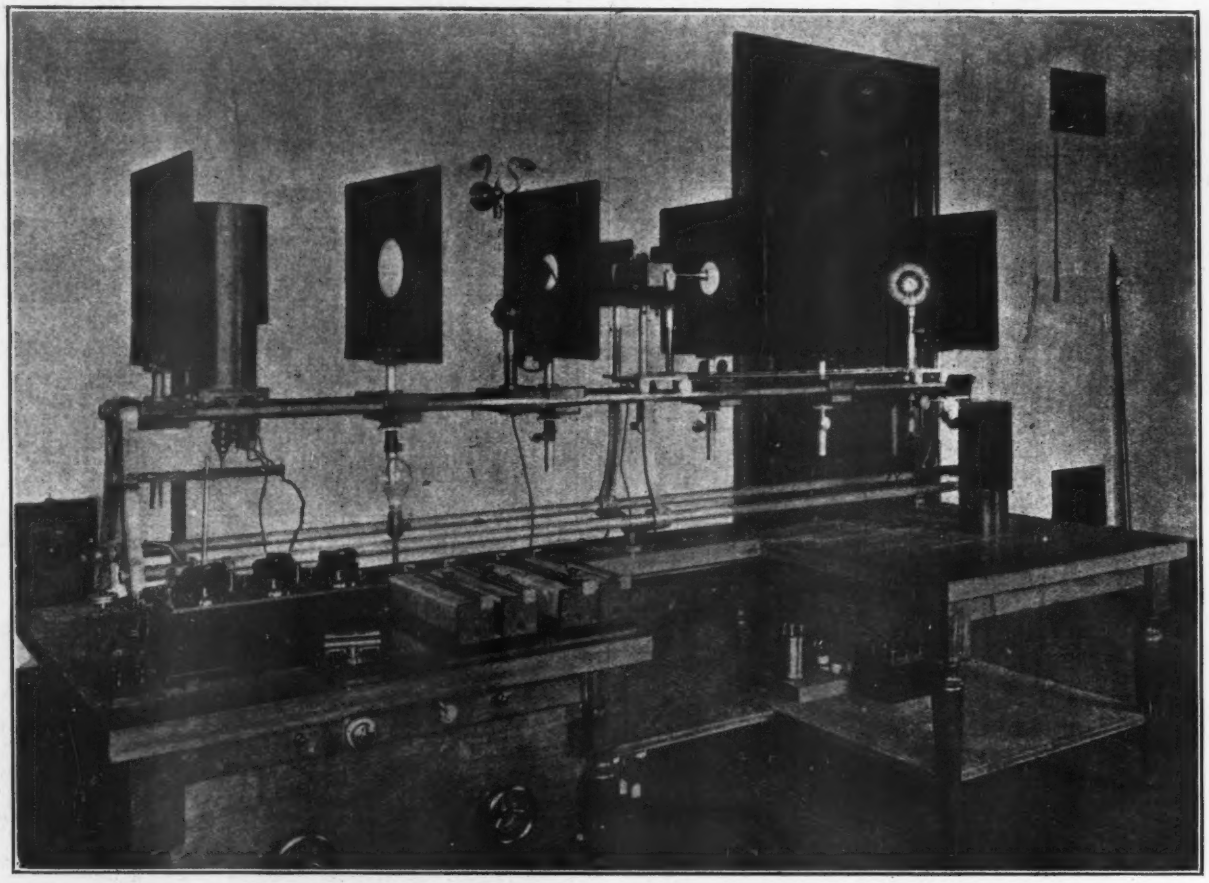


Fig. 1.—Standard Photometrical Bench, The Bureau of Standards, Washington.

The standard and test lamps are placed successively in the socket on the left, and measured either stationary or rotating as occasion may demand. The horizontal rotator (shown in the photograph with the driving shaft disconnected) was designed and constructed at the Bureau. It has four rotating mercury contacts—two for current and two for voltage. The shell and the base of the socket are each divided into two parts, insulated from each other, to one of which the current lead is connected, and to the other the potential lead. In this way the voltage is measured on the base of the lamp, reducing greatly any error that may be due to a bad contact between the base of the lamp and the socket.

The sectored disk shown in the photograph is used, when rotating, to reduce the apparent intensity of a source by a known amount. In Fig. 2 it is shown on a large scale, mounted directly on the shaft of a small motor in the way in which it is generally used.

All of the electrical measurements are made by means of a potentiometer in terms of a Weston standard cell. The voltage of the lamps is reduced by a suitable multiplier, and current is determined by the

1. The *Illuminating Engineer*, London.

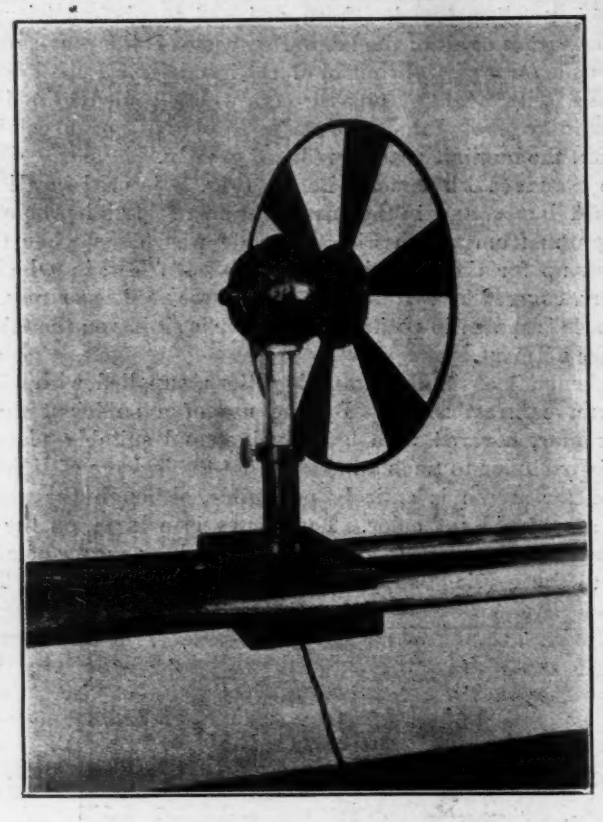


Fig. 2.—Rotating Sector Disk.

fall in potential across a standard resistance. By means of a convenient multiple switch, mounted in front of the potentiometer, voltage or current on either lamp can be determined quickly with an accuracy of one or two parts in 10,000. The galvanometer is mounted on the wall several feet behind the bench, but the spot of light is focussed on a graduated scale right behind the potentiometer, and at a convenient height for observation.

A new universal support and rotator recently constructed at the Bureau (Fig. 3) may be mounted on one of the standard carriages belonging to the bench, for determining distribution curves around incandescent lamps. This instrument may be used either as a universal rotator, or as a universal lamp holder, since it is provided with two graduated circles in planes perpendicular to each other. A lamp may be set quickly to any latitude and azimuth, with an accuracy of a fraction of 1°. The axis of rotation is horizontal, making possible the use of mercury contacts. Any lamp from 4-candle power to 100-candle power can be measured, and many types of reflector shades and diffusing globes can be mounted with the lamps. By means of an adjustable counterpoise the instrument is always in equilibrium and therefore free from mechanical strains.

In Fig. 4 is shown the integrating photometer for the direct measurement of mean spherical and mean hemispherical candle power of incandescent lamps. It is of the Matthews' pattern modified in theory and construction. It is 10½ feet high, and is provided with 20 pairs of mirrors. It is installed in a room by itself, and although the walls and floor are as nearly dead black as could be procured conveniently, black velvet has to be used freely in order to eliminate stray light. The black velvet was removed when the photograph was taken.

The instrument is provided with a Lummer-Brodhun contrast photometer screen. The test lamp is mounted in a special form of rotator which has two sockets—one upright and one inverted—so that the new types of lamps with weak filaments can be mounted and even rotated at a low speed. The comparison lamp is moved to-and-fro by means of a graduated steel tape on which the distance is read. Voltage is measured on a laboratory standard voltmeter, and current by means of a millivoltmeter and shunt.

The Commercial Bench (Fig. 5), set up in the same room with the Standard Photometer, is used principally in testing samples of lamps purchased by the Government departments. This bench was specially designed and constructed in the instrument shop of the Bureau. The horizontal rotator, mounted on the left, was purchased from the General Electric Company. It is equipped with the ordinary treadle for reversing the direction of rotation, so that lamps can be spun into and out of the socket. To the left of the horizontal rotator is a special end-on rotator made at the Bureau, for the purpose of determining the candle power of lamps in the direction of the tip, since this is frequently specified in the purchase of incandescent lamps. This end-on rotator is driven by means of a belt running over a pulley on the vertical shaft of the horizontal rotator, so that both are driven by the same motor and at the same speed, direct and reversed. Both rotators are provided with mercury contacts.

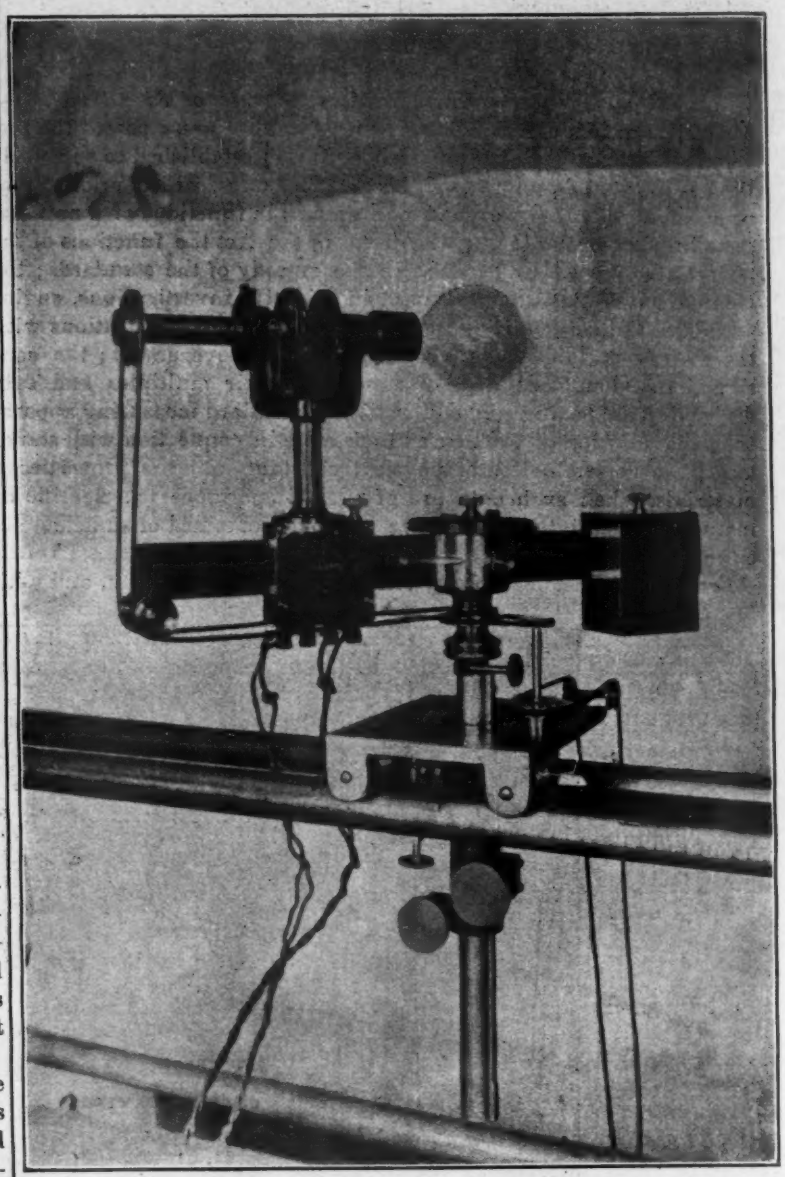


Fig. 3.—New Universal Support and Rotator for Glow Lamp Tests.

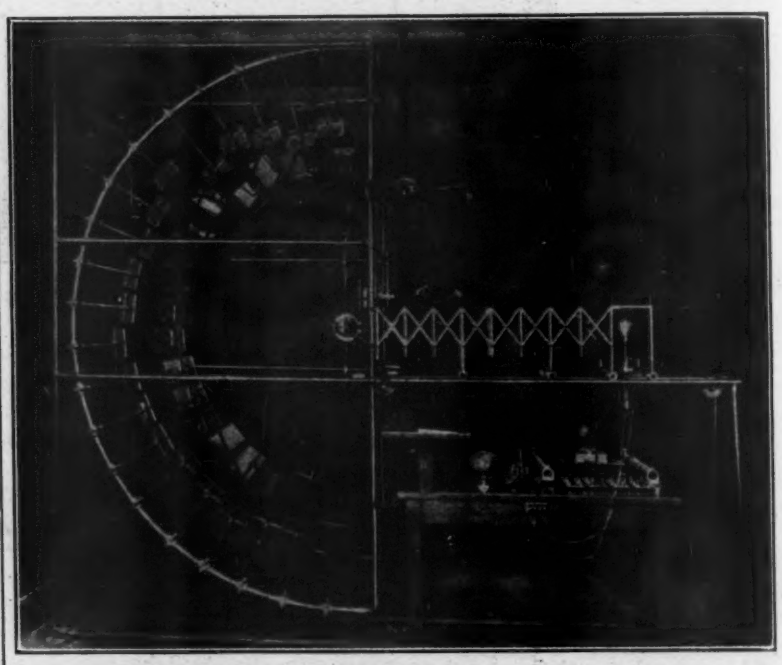


Fig. 4.—Matthews Integrating Photometer.

The comparison lamp is mounted in a fixed position at the other end of the bench, and the voltage on this lamp is adjusted until there is a balance against the standard lamp when the photometer screen is

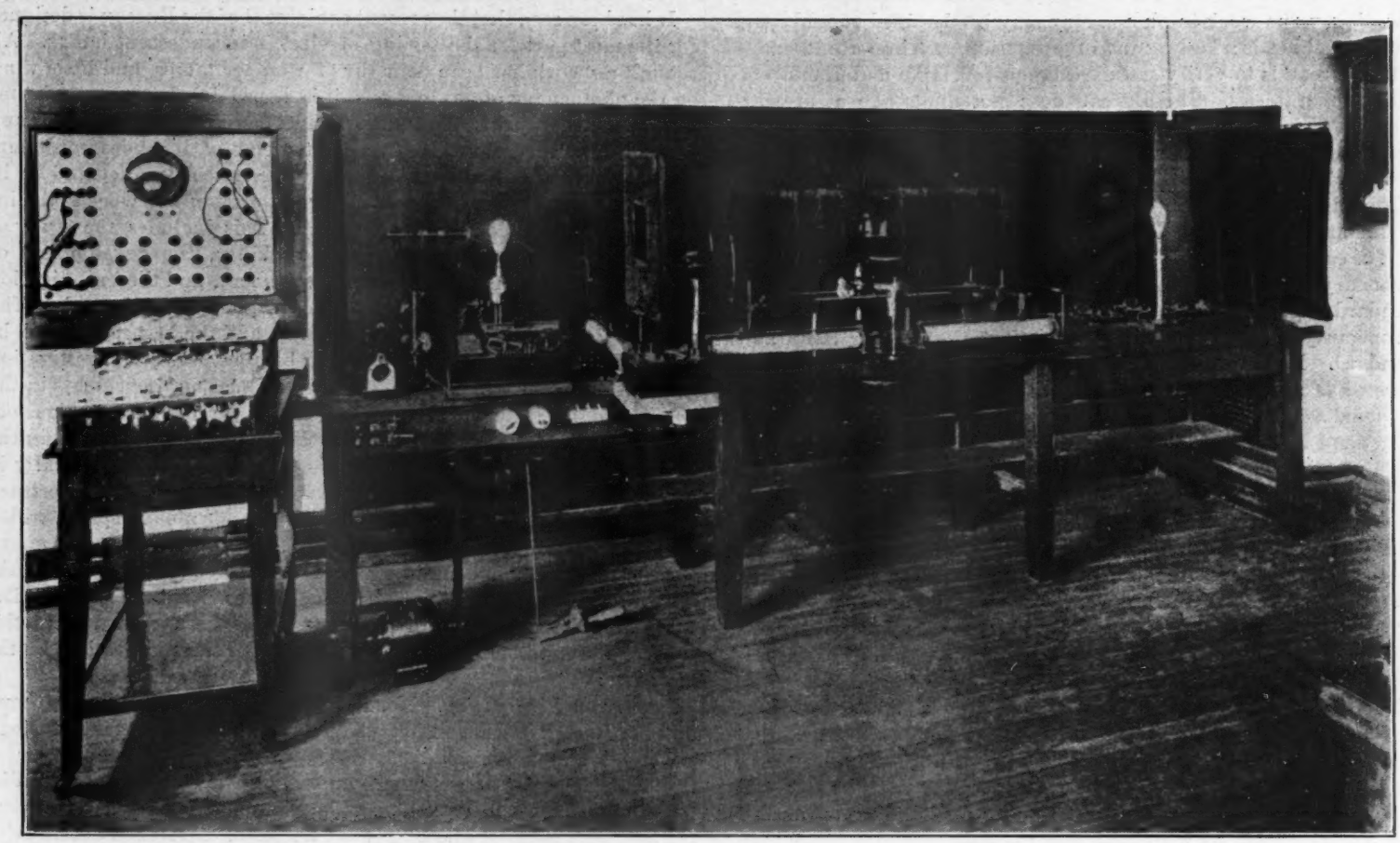


Fig. 5.—Photometrical Bench for Commercial Testing.

placed at 16-candle power or at the proper point on the scale corresponding to the candle power of the standard lamp. The screen is moved to-and-fro over a limited distance by means of a belt operated by a wheel situated under the table and in a convenient position for the hands of the observer.

A new feature of this bench is the multiple candle power scale, which, in conjunction with a variable rotating sectored disk, permits of direct candle power readings for lamps of all intensities, without moving the photometer screen over any great range of distance. One of the pieces of steel tubing forming the track is slotted, and within this tube is mounted a rotating drum graduated with 5 or 6 different candle power scales and operated by means of a thumbscrew. By turning the drum the desired candle power scale can be brought beneath the slot. If 50-candle power lamps are to be measured, the variable disk is set to the proper angular opening and rotated, and the 50-candle power scale is used. The intensities of lamps in the neighborhood of 50-candle power can then be read directly without moving the photometer any considerable distance from the central position. This latter feature is a distinct advantage, on the ground both of accuracy and of convenience. When lamps of a lower candle power than 16 are to be measured, such as 8-candle power or 4-candle power lamps, the sectored disk is placed on the other side of the screen, between it and the comparison lamp.

The voltage measurements are made by means of a deflection potentiometer recently designed at the Bureau by Mr. H. B. Brooks. With this instrument the voltage can readily be adjusted to 0.1 volt or better in less time than it takes to make a corresponding adjustment with a voltmeter, and the accuracy of the instrument is much higher. The energy supplied to the lamp is measured on a Weston wattmeter. This instrument, in connection with a variable resistance controlled by the position of the photometer screen, permits of direct readings of watts per candle. In series with the pressure circuit of the wattmeter are two resistance blocks bridged by a sliding contact fastened on the moving carriage which holds the photometer screen. The resistance in series with the pressure circuit of the wattmeter is always such for any position of the photometer screen that the watts are cut down in inverse proportion to the candle power, so that the wattmeter indicates watts per candle directly.

In the new room which has recently been assigned to photometric work, another photometer bench will be installed within the next few months. The plans for this bench, which will be constructed in the instrument shop of the Bureau, are being drawn up now, but not sufficient progress has been made to warrant any descripiton at this time.

The small amount of life testing of incandescent lamps which the Bureau has undertaken in the past has been one on direct current, but a 40-kilowatt alternating current generator has recently been installed for this work, and plans are now in progress to increase the capacity of the life-rack from 200 lamps to 500 or 1,000. The life-racks are not located in the laboratory rooms, but in a separate large room in the attic.

In addition to the several complete photometer benches which have been described there is much auxiliary apparatus which constitutes an important part of the equipment. A Brace spectro-photometer, with a special form of variable sector, made by Franz Schmidt and Haensch, of Berlin, from designs by Prof. Brodhun, is provided for studying the spectral distribution of light from radiant sources. Flicker photometers of both the Simmance-Abady and the Franz Schmidt and Haensch forms have also been secured. An order has recently been placed for a large spectro-photometer of the Lummer-Brodhun type, together with a Lummer-Brodhun sectored disk, the opening of which can be varied and read while the disk is rotating.

As stated in previous paragraphs, the Bureau has a number of sectored disks of fixed opening, and two or three of variable opening of the ordinary form, ranging in opening from 0° to 180°. In addition to these there is one special variable opening disk that was constructed by W. and L. E. Gurley upon designs furnished by the Bureau. This disk is composed of two principal component disks, each having a fixed opening of 300°, and a number of very thin auxiliary disks whose only function is to close the gap formed between the two principal disks when these are moved over one another in such a way as to reduce the angle between their calibrated edges. Between 300° and 240° this fan-like set of very thin disks does not come into play, but when the angle between the calibrated edges of the two principal disks is made less than 240° the disks no longer overlap, so that there is an opening between the other edges. This opening is covered by the auxiliary disks. The total range of the disk is from 0° to about 300°. It is calibrated not only in degrees but in per cent. of total opening, and also in candle power for use in the industrial photometry of incandescent lamps.

The standard lamps of the Bureau constitute an important part of the equipment. These include 5 Hefner lamps, 2 Vernon-Harcourt, 10-candle power pentane lamps, 1 carcel lamp, and a large number of incandescent lamp secondary and working standards.

Testing.—The work in photometry may be classified roughly under two general heads: Testing and investigation. An important function of the Bureau is to verify standard lamps for lamp manufacturers or testing laboratories. The Bureau does not undertake at present to supply standard lamps, or to season new lamps for use as standards, but if seasoned lamps are submitted they are standardized at a nominal fee.

The question is frequently asked, "What standard of candle power is used at the Bureau?" Although the Bureau has adopted a definite unit of candle power, which it maintains through incandescent lamp secondary standards, it has not as yet adopted a primary photometric standard. This fact should be emphasized, as it is sometimes stated erroneously that the Bureau has adopted the Hefner lamp as the standard. Neither the Hefner nor any other lamp has been or will be adopted as a primary standard until the various lamps that have been proposed as standards have been investigated thoroughly. What has been done has been to adopt a unit of candle power which bears a certain ratio (100 : 88) to the Hefner unit as maintained at the Reichsanstalt. At the time of the inauguration of the work in photometry at the Bureau this seemed to be the best way of arriving at the English parliamentary candle, which was supposed to be the common unit of candle power in the United States both for gas and electric lamps. Inasmuch as the unit can probably be maintained constant through incandescent lamp secondary standards for an indefinite period, the adoption of a primary standard, though important, is not immediately urgent.

This distinction between a unit of light and a standard of light in terms of which the unit is expressed, has suggested the possibility of international agreement upon a common unit of luminous intensity for England, France and the United States. The units in use in these three countries are so nearly alike that no serious results would follow a compromise by which all three countries would agree upon a common unit of candle power. The suggestion is, that without in any way involving the question of primary standards, England, France, and the United States shall agree upon a common unit of candle power which shall represent an average value of the units in the three countries. Each country will maintain this unit at its national laboratory in any way it may choose; *i. e.*, through pentane lamps, Carcel lamps, or incandescent lamp secondary standards, but by frequent intercomparisons among the various laboratories by means of incandescent lamps measured at each laboratory, the unit may be kept the same in the different countries.

It is probable that Germany would not be willing to change its unit by as much as 10 or 15 per cent., at least at present, but the ratio of the Hefner to the international candle could be determined and defined.

The adoption of a common unit of candle power as distinguished from a standard lamp, suggests further a more complete differentiation of the functions of primary and working standards, and reduces the requirements demanded of each class of standards. On the one hand we should seek as a permanent custodian of the unit a primary standard, of which the only requirements would be a suitable color, a suitable intensity and exact reproducibility. It need not necessarily be simple, or inexpensive, or of great constancy over a long period of use. On the other hand, our working standards need no longer have the requisite reproducibility of a primary standard, but must remain constant after having been calibrated in terms of the unit. The seasoned incandescent lamp fulfils these requirements admirably for the photometry of electric lamps, but in the photometry of gas it is desirable to have flame standards that vary in intensity with changes in the atmosphere in the same direction and approximately to the same extent as the gas flame. It has usually been the custom heretofore to employ primary standards, such as the pentane lamp, in the photometry of gas, but is it not possible that a cheap and portable lamp might be found which would remain constant in intensity after having been calibrated, and which would be more convenient and more easily manipulated than the Harcourt 10-candle power pentane lamp?

In addition to the testing of secondary or working standards the Bureau undertakes to do a certain amount of commercial testing for various departments of the Government, and for private firms or individuals in cases of dispute, or where authoritative results are especially desired. It is prepared at all times to make special tests whenever these are practicable, to render assistance in the development of the proper methods of measuring luminous sources and illumination, and to aid as far as possible both the manufacturer and the consumer in preparing suitable specifications for the purchase of lamps.

It has been seen that the present equipment of the Bureau is designed for the most part for the testing of electric incandescent lamps. Although no work has been done thus far on arc lamps, and little work on the photometry of gas and oils, it is hoped in the course of time to broaden the work so that there will be facilities for measuring any kind of luminous sources. The photometry of incandescent lamps has been developed first because there seemed to be more demand for it.

Investigation.—Not the least important part of the work is the investigation of problems in photometry. This includes the study of standards (primary, secondary and working), the development of accurate methods of photometric measurement, and the investigation of physical laws upon which the science of photometry depends, The scope of the work is therefore very broad, and the best results can be accomplished by maintaining a proper balance between investigation and testing. The one makes possible continual improvements in the other, and this in turn suggests fertile fields for further investigation.

The results of the investigations at the Bureau are published in the *Bulletin* of the Bureau of Standards, and also at times, usually in abstract form, in some of the technical journals. Each paper printed in the *Bulletin* is published separately in the form of a reprint, which may be obtained upon application. A list of the papers published up to the present time, containing in a few words a statement of the nature or results of each investigation, has recently been issued. The following list of papers in photometry has been copied from this source, the numbers referring to the order of publication in the *Bulletin*:

Papers on Photometry.—No. 12. On the "Theory of the Matthews and the Russell-Léonard Photometers for the Measurement of Mean Spherical and Mean Hemispherical Intensities." The accuracy of these instruments in measuring lamps with various simple polar distribution curves is investigated. The method is given for computing the best arrangement of any given number of mirrors to obtain relative values between lamps having different distribution curves.

No. 20. "The Use of White Walls in a Photometric Laboratory." If proper black velvet screens are employed on a photometer bench the leakage of light into the photometer due to the diffuse reflection from white walls is shown to be so small as to be negligible.

No. 26. "Talbot's Law as Applied to the Rotating Sectored Disk." The apparent intensity of a source, before which a sectored disk is rotating rapidly, is found to be proportional to the total angular opening of the sectored disk for all angles between 288° and 10°.

No. 30. "An Efficiency Meter for Electric Incandescent Lamps." By means of a variable resistance in series with the pressure circuit of a wattmeter and controlled by the position of the photometer screen, the wattmeter is made to indicate watts per candle directly.

No. 43. "On the Determination of the Mean Horizontal Intensity of Incandescent Lamps by the Rotating Lamp Method." A study of the errors incident to this method, due (1) to the distortion of the filament on rotation, and (2) to the inability of the eye to estimate accurately a badly flickering illumination. By the use of a single stationary mirror accurate measurements of mean horizontal candle power can be made even with badly flickering lamps.

No. 50. "A Comparison of the Unit of Luminous Intensity of the United States with those of Germany, England and France." A number of seasoned incandescent lamps were carried abroad and measured in authoritative laboratories in the three countries named. The ratios of the units obtained through them are compared with the ratios generally accepted, and with those obtained in other recent investigations.

No. 51. "Geometrical Theory of Radiating Surfaces with Discussion of Light Tubes." Assuming Lambert's cosine law and the inverse square law to apply to infinitesimal surfaces, the errors incident to applying them to finite surfaces are deduced for several simple cases. From a consideration of the case of an infinitely long, uniformly bright strip of finite width a theory of light tubes is developed.

No. 61. "An Explanation of the Short Life of Frosted Lamps." The rapid decrease in candle power of frosted lamps is due, at least partly, to the increased absorption of the carbon film deposited on the inner side of the bulb. Owing to the diffuse reflection at the frosted surface a relatively large part of the emitted light is compelled to traverse the absorbing carbon film three or more times before finally emerging. Results of confirmatory experiments are given.

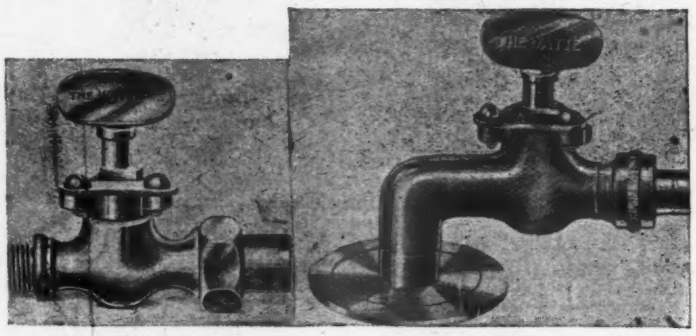
No. 63. "On the Determination of the Mean Horizontal Intensity of Incandescent Lamps." A continuation of a previous investigation on this subject (see Reprint No. 43). Other types of lamps are studied, and the methods and results of similar experiments by Uppenborn are discussed.

No. 72. "A Comparative Study of Plain and Frosted Lamps." The various effects of frosting the bulbs of carbon filament incandescent lamps are studied as changes in (1) absorption, (2) distribution, and (3) life.

1. New lamps show an absorption of only 2 or 3 per cent. which increases rapidly as the lamp burns. 2. The distribution of light around frosted lamps depends on (*a*) the distribution curve of the bare lamps, and on (*b*) the shape of the bulb. 3. The theory advanced in a previous paper (see Reprint No. 61) to account for the short life of frosted lamps is further substantiated. Readings are given of the temperatures of the bulbs of plain and frosted lamps, both new and old.

The Wayte Safety Tap for Gas Cookers and Gas Fires.

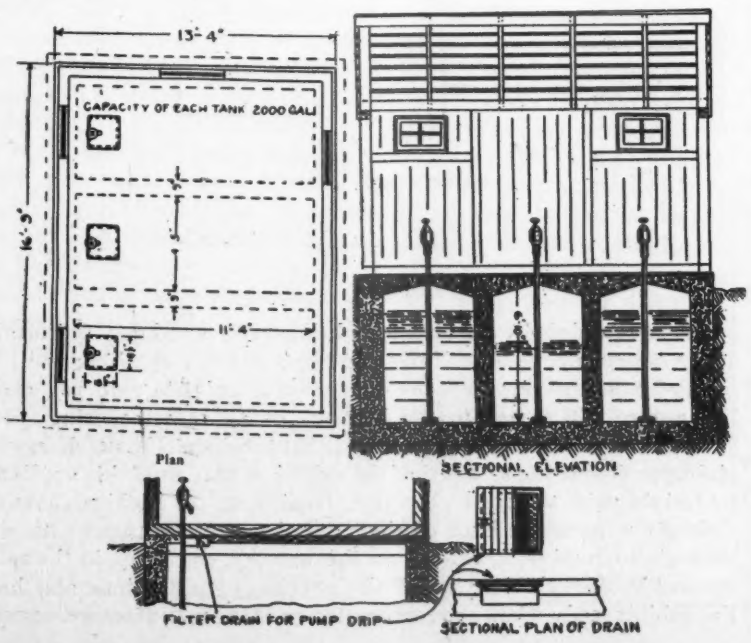
The *Gas World* having noted that the tap of the average gas fire is a very accessible affair, and as it is not always so hard to move as the dictates of safety might suggest, and remembering that careless servants and venturesome children are frequently in evidence, goes on to explain *that* the "Wayte" patent trap, which is now being introduced in England by Messrs. G. Hands & Co., Farringdon Road, London, offers a means of making safety look a surety. The Wayte does not differ much in appearance from an ordinary tap, as will be seen from the illustrations, which show two types. But the special



feature in it is that it cannot be opened by a simple turn. The plug has to be pressed down against a spring before it can be turned to the open position. Herein lies the safety of the "Wayte" tap. As to open it a downward thrust must be applied, it is almost inconceivable that it can be opened by accident; and he will be a very artful child who discovers the secret of that downward thrust. The closing of the tap does not require the downward thrust. The "Wayte" patent safety attachment can be applied to any style of tap, and it goes without saying that its usefulness is not limited to gas fires.

Concrete Oil Tanks.

The *Concrete Review*, in reply to many inquiries relative to the use of concrete in tanks for the storage of oil which, owing to its absolutely fireproof qualities, is wonderfully well fitted for the purpose, prints the accompanying sketch showing how one cement company has constructed a series of three tanks for use in this way.



The concrete was made of one part Portland cement, two parts sand and four parts crushed stone passing through a 1-inch ring. The interior walls were plastered with a rich Portland cement mortar, smoothed and well trowelled in order to give a dense finish to the plaster lining. The tank has been in use since 1900, and has never leaked, giving perfect satisfaction.

Cylinder, crank, case and block oil are stored in the three divisions of the tank.

Exhibition of Gas Appliances, on Joint Account The National Commercial Gas Association and The American Gas Institute, Chicago.

The American Gas Institute has joined hands with the National Commercial Gas Association for the purpose of exploiting gas appliances at the time of the meeting of the National Commercial Gas Association, week of December 7th, 1908, in Chicago.

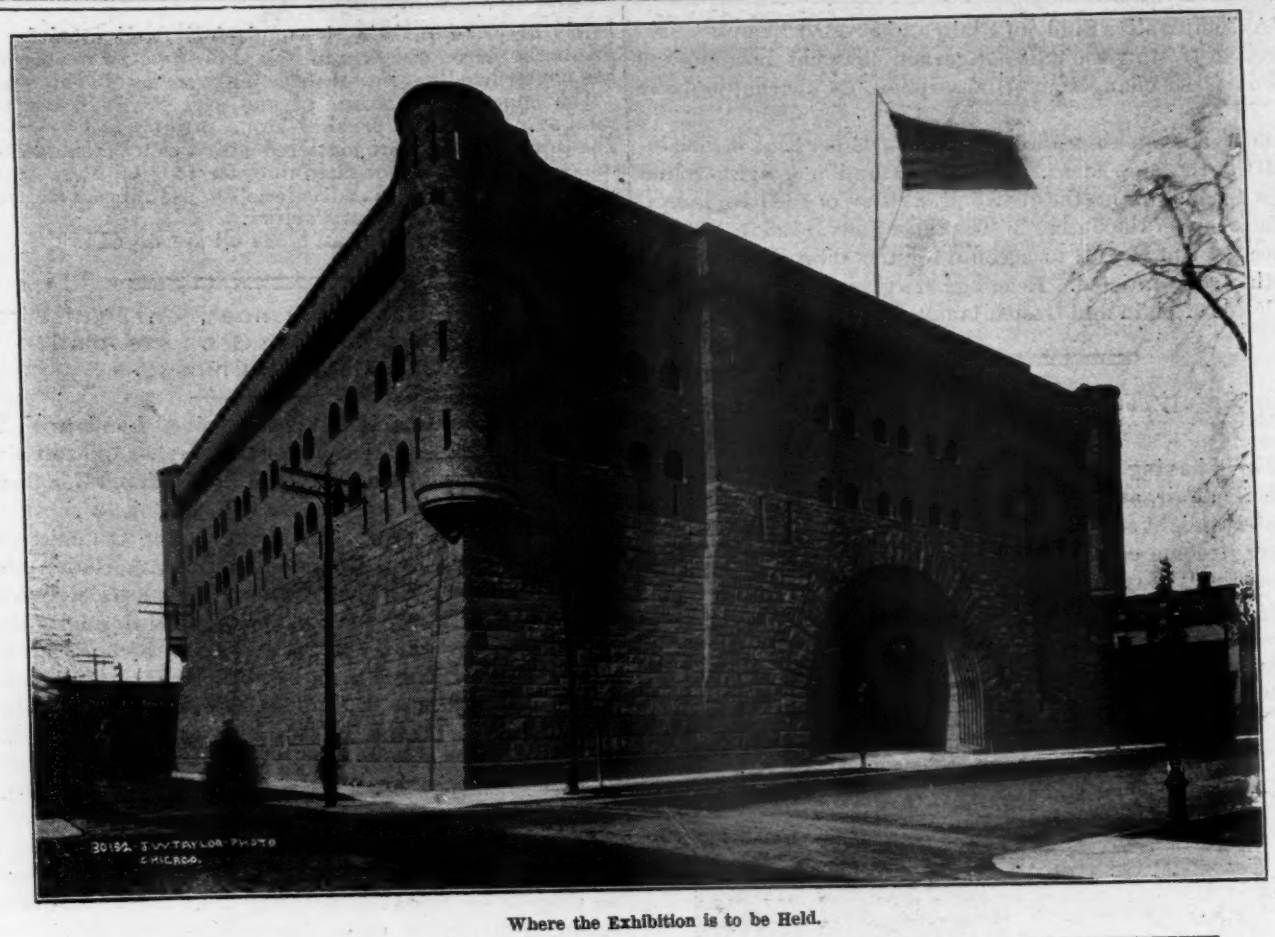
Mr. John C. D. Clark, Chairman of the Committee of Arrangements of the National Commercial Gas Association and President Frank W. Frueauff, of the National Commercial Gas Association, met in Chicago, Thursday September 3d, and informally closed the final arrangements by which the gas exposition becomes an assured fact.

There is need of such an exposition. The first of its kind was held in London, England, in 1882, and the second was held in Earl's Court, London, in 1904. The third was held in New York city, in January and February, 1897. This exposition was undertaken by Mr. E. C. Brown, aided by the Ohio Gas Light Association, and it was eminently successful during the two weeks it remained open. These three expositions are the only apparently serious attempts to exploit gas to the general public, and they were a complete success. The attendance was excellent, and the utmost satisfaction was expressed, not only by those who attended, but especially by the exhibitors who profited largely by the extended knowledge of their appliances which they thus secured.

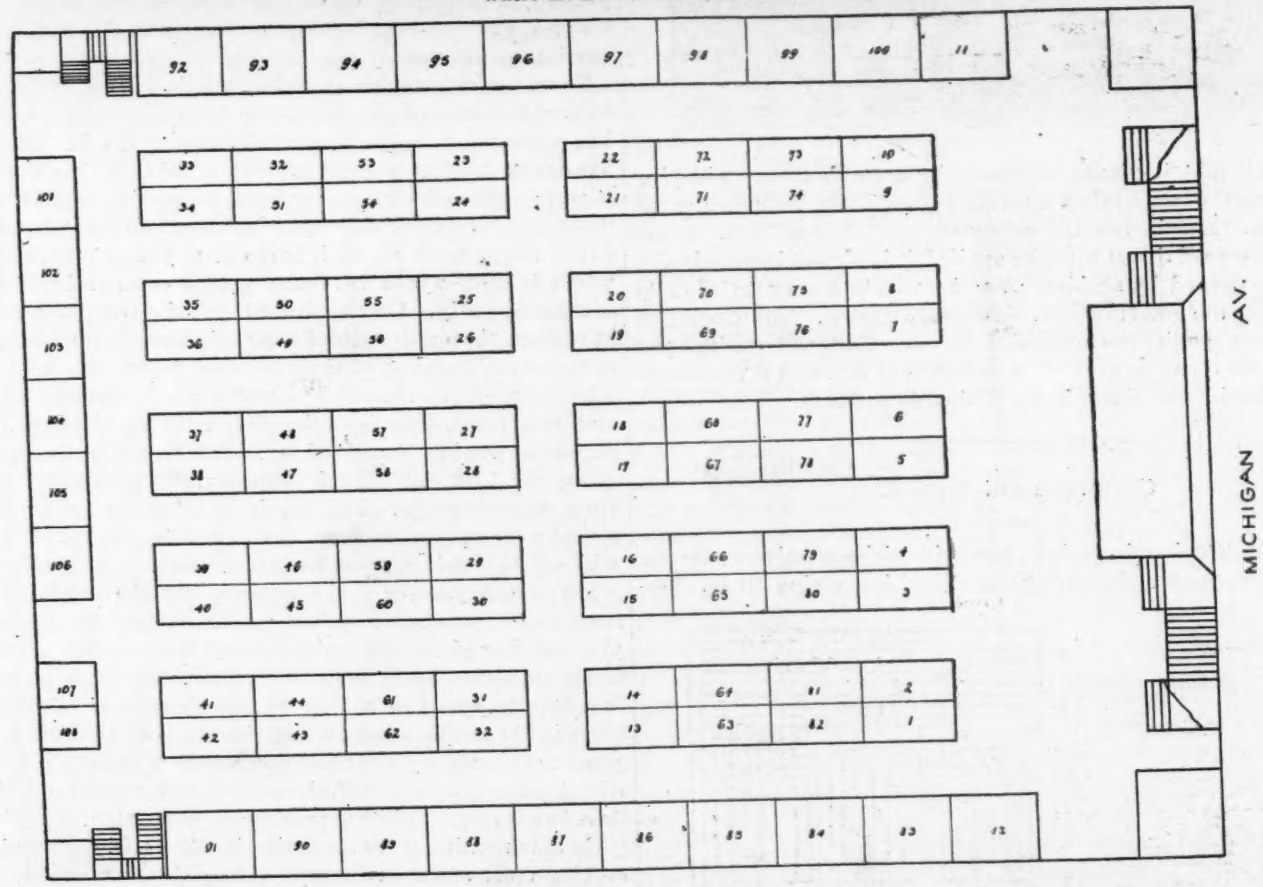
There are many more spectacular industries than that of the manufacture and sale of gas, but there are few as important. Electricity has presented so attractive a field during the last generation that it has drawn to it an even greater share of attention than it deserved. It certainly has drawn a very large proportion of the young engineering minds, and in a large measure the rapid progress of electricity is due to the promise which it held out to young men, and the rich rewards to those whose inventive genius has developed that industry so magnificently. On the other hand, the competitive efforts which have been the outgrowth of the rapid introduction of electricity led to a great stimulation of the gas industry, and this field of enterprise, which some have regarded as pretty well cultivated and to some extent exhausted, has been bearing fruit as the result of research almost as rapidly as electricity. The candle power yielded by gas to-day per 1,000 cubic feet is immeasurably in advance of what it was but a short time ago. The development of the gas engine is opening a field which promises some day to become the source of power from which the electric current itself is derived.

The use of gas for fuel purposes, and the extended, in fact the marvelous, introduction of the gas stove has solved many a kitchen problem, has given the public better food, is doing away with the smoke nuisance, and is in fact a civilizer. All these things are known in a desultory sort of a way by the general public, but there still lurks in the public mind an idea that the gas industry is being relegated to oblivion by a competition which it has not only been able to withstand but to successfully overcome by sheer merit. There is, therefore, every possible reason for an exposition.

There is nothing more attractive in the world than light. There is nothing more useful in the world than heat or power. An exposition of the exquisite beauties of the first, and the marvelous results in economy of the latter, are bound to attract a great deal of attention. However, it is not only the general public who will derive benefit from the educational efforts put forth, and thus come to utilize more freely the invisible but potent product of the generating vessels, but the exposition will give an opportunity to the manufacturers of appliances to display under service conditions the merits of their pro ducts to the entire gas fraternity, and this at a time when the minds of all are devoted to a clearer and better understanding of the progress and possibilities of gas. No person in the gas industry can afford to miss the opportunity to see these appliances under service conditions. The exposition, therefore, is calculated to bring all the industry together, to call the attention of the general public to the



Where the Exhibition is to be Held.



magnitude and dignity, to the tremendous progress and great possibilities of gas in every field.

It is a fortunate thing that the American Gas Institute and the National Commercial Gas Association joined hands in the development of the enterprise, so there can be no doubt of its great success. While the prospectus has not yet been prepared it will soon be issued and then sent to all those interested, or can be had upon application. Nevertheless, the general preliminary arrangements can now be stated. First, among other innovations one stands out clearly as of great advantage to the exhibitor. The space in the First Regiment Armory, of Chicago, will be divided in equal portions, platforms built surrounded by handsome columns and arranged uniformly. The Armory will be beautifully decorated and the exhibitors will be enabled to secure one or more spaces at a uniform rate per space. Due regard will be had to the interests of all those securing space. The space once secured it is proposed that there shall be no charge for piping or connections, and that the exhibitor may send his appliance by freight paid, to John C. D. Clark, Chairman, 157 Michigan avenue, Chicago, who, as the head of the Committee of Arrangements, will arrange to receive it, deliver to the armory, set it up in the space secured by the exhibitor, make the necessary connections and have the exhibit ready when the representative of the manufacturer appears

to take charge. At the close of the exposition it is proposed to take the exhibits down, repack them and deliver them to the proper freight depot in Chicago, addressed to the manufacturer. This is almost revolutionary, as hitherto the exhibitor has been obliged to send men ahead to secure the necessary mechanics and expend an immense amount of energy and large sums of money, whereas, under the present arrangement, the detail falls upon the Committee, and the manufacturer is thus enabled to figure very closely as to what his exhibit will cost.

Gas for all ordinary exhibition purposes will be supplied free.

The building will be open to the public between 2 P.M. and 11 P.M., during the entire week. Admission will be free and the public generally invited to attend.

A great deal of publicity will be given to the exposition, especially outside of Chicago in the larger cities and towns, with a view to carrying out the educational feature, the necesity of which is so apparent. The idea is to let the people of the United States know, as a matter of fact, that the gas industry is a tremendous and advancing business; that there is something of it beside a few fixtures which the public sees and the gas mains which lie beneath the streets; that back of the constant pressure at the burner is a great manufacturing enterprise the possibilities of which are just beginning to be realized. That the gas industry is stable, that its value as an investment is not impaired by competition, and that its destiny is as important as that of any other modern enterprise.

The meetings of the National Commercial Gas Association will take place during the three days, beginning December 8th. Meetings will be held in the exposition building. Adjournment will be had each day that the members of the Association may have ample opportunity to examine in detail each exhibit.

Lunch will be furnished to the members as a part of a splendid entertainment programme which is being prepared, for which it has been decided to prepare entertainment tickets at $6 each. Ladies are especially, and most cordially, invited to attend the convention, and, of course, special arrangements for their entertainment will be made.

Excellent music will be furnished at the exposition from 7:30 to 11 each evening. Taken all in all, the plans are most comprehensive.

The necessity for an exposition must be apparent to all, and this necessity amounts to a demand upon all those who are in any way connected with the industry to put their shoulder to the wheel and make it an overwhelming success.

Gas Reactions and their Industrial Application.—No. I.[1]

By Thomas Holgate, London, England.

During recent years much attention has been bestowed upon the obscure points connected with the chemical actions that take place at high temperatures, and especially of those which have a large industrial importance. Intimately associated with this quest is the collateral one of the determination with satisfactory accuracy of the temperatures employed. The investigations in both these departments have been conducted mainly on the Continent, and of the former more especially at the University of Berlin, by the Institute of Physical Chemistry, whose director is Professor Walther Nernst. As will be shown later in this review, it is the object of several of the investigations so completely to ascertain the behavior of the normal products of combustion, water and carbon dioxide, at successive temperatures that the quantity of the dissociation products or their pressure may enable temperatures to be inferred that are otherwise impossible of measurement, or nearly so. As thus viewed, it is reasonable to expect that each line of research will assist the other to reliable practical conclusions.

In addition to the investigations that are being pursued along an ordered course, dealing with the fundamentals, there are inquiries, by eminent authorities, into special problems that arise technically as special forms or combinations of the fundamentals, and progress in these, of necessity, cannot be chronicled in the same methodical way. Each careful observation must be recorded and classified, so that its relation to previous work may be understood and its bearing towards further research duly appraised.

The Law of Mass Action.—In describing the various experiments conducted to obtain reliable data, only so much will be mentioned as is necessary to explain the principles involved. A convenient starting point, historically, is the series of experiments conducted by O. Hahn in 1903 to ascertain the course of the interaction between hydrogen and carbon dioxide, when carbon monoxide and water in equal volumes are produced, or the inverse action, according to the reversible equation: $CO_2 + H_2 \rightleftarrows CO + H_2O$. Having first found by trial at a *constant temperature*, with mixtures containing varying proportions of carbon dioxide and hydrogen, that Guldberg and Waage's law of mass action was applicable, Hahn then verified the applicability of the same law at *successive temperatures* between (686° + 273°) and (1,405° + 273°) C. The expression of the law is given by the relation of K, the equilibrium constant, to the concentration of the gases, viz., $K = \frac{[CO][H_2O]}{[CO_2][H_2]}$, where the concentration of the gases is indicated by the formula inclosed between square brackets. By analyzing the gases before and after subjection to the specific temperatures, the concentration of each component was determined, and by the preceding equation the equilibrium constant K found. At the centigrade temperature (686° + 273°) K was 0.534, at 1,005° + 273° = 1.62, at 1,205° + 273° = 2.12, and at (1,405° + 273°) = 2.49. The addition of 273° to the observed temperature enables the absolute temperatures to be compared and gives T, referred to in the various equations that make use of the various adaptations of the fundamental gas equation PV = RT.

The series of experimental results, of which the above are a part, were compared, for each temperature, with the figure calculated by van't Hoff's equation, which expresses the relation of the "heat of reaction" with the temperature of the experiment, viz., $\frac{d \log_e K}{d T} = \frac{-q}{RT_2}$, when satisfactory agreement was found to exist. By taking the actual molecular heats at constant pressure as calculated by Le Chatelier (1887) the equation became $\log. K = -\frac{2,226}{T} - 0.0003909\,T + 2.4506$, which gave a close approximation to Hahn's experimental results of K. The latter were further confirmed by Dr. F. Haber and Dr. F. Reichardt, who investigated the water gas equilibrium in the Bunsen flame as well as the chemical determination of flame temperatures.

Examination of the Bunsen Flame.—The two cones of the Bunsen flame, such as is used in incandescent gas burners, were separated by the method of Professor A. Smithells and Herbert Ingle, of Leeds. The gases cooled from the inner cone were analyzed, and the volume relations between the four substances, carbon dioxide, hydrogen, carbon monoxide and water vapor, determined. It was found that in the green inner cone, such as is desired in the most efficient incandescent burners, the water gas equilibrium $CO + H_2O \rightleftarrows CO_2 + H_2$ is produced very rapidly. The equilibrium constant of the system was (within the limits of experimental error) the same as that calculated from Hahn's results for the temperature of this zone, and they represent their results in a diagram of reaction isochores of water gases in which the ordinates are equilibrium constants and the abscissæ temperatures. Drs. Haber and Reichardt concluded from the experiments that the same result for the temperature of the inner combustion zone is obtained by calculation from the composition of the products of combustion by the aid of the reaction isochore of the water gas equilibrium as by thermo-eclectric measurements, and also as obtained by calculation from the heats of combustion and specific heats (Mallard and Le Chatelier) of the individual gases.

The term "reaction isochore," introduced by Nernst, is applied to the equation of van't Hoff, given above, to denote that it relates to the influence of temperature upon the equilibrium of a system at *constant volume* in contrast to the "reaction isotherm," which relates to the influence of changes in concentration at *constant temperature*. The latter is the one commonly spoken of as the law of mass action.

Dissociation of Water Vapor.—It will be noticed that the chemical change occurring in the primary stage of the combustion of the gases involves two important factors, namely, the dissociation of water vapor and that of carbon dioxide. Accepting Hahn's experimental results, Nernst has deduced therefrom the ratio that exists in these dissociations at (1,000° + 273°) C. Taking K to be, at this temperature, 1.6, he finds the ratio of the dissociation of water to be 0.73 times that of carbon dioxide. The method (which is, of course, applicable for deducing the ratio at the other temperatures) is as follows: If K_1 and K_2 represent the dissociation constants of water vapor and of carbon dioxide, respectively, and x and y represent their degree of dissociation, then $K = \frac{[H_2]^2[O_2]}{[H_2O]^2} = \frac{x^3}{2v\,(1-x)^2}$, where v is the volume in which a molecule of water is contained and consequently

1. *Gas World.*

$[O_2] = \frac{x}{2v}$, $[H_2O] = \frac{1-x}{v}$; and similarly $K_2 = \frac{[CO]^2 O_2]}{[CO_2]^2} = \frac{y^3}{2v\,(1-y)^2}$. By dividing the latter by the former, and remembering that $K = \frac{[CO]\,[H_2O]}{[CO_2]\,[H_2]}$, then we get $K^2 = \frac{K_2}{K_1} = \frac{y^3\,(1-x)^2}{x^2\,(1-y)^2}$, and by taking K as 1.6 for the temperature (1,000° + 273° C.) we find x to be 0.73 times y.

In 1888 Le Chatelier calculated the dissociation of carbon dioxide at temperatures ranging from 1,000° to 4,000° C., and pressures from 0.01 to 100 atmospheres, and since Hahn's experiments Nernst advised that until more exact measurements were obtainable, the dissociation of water vapor at high temperatures might be approximately calculated by multiplying the numbers in Le Chatelier's table for CO_2 by 0.73. Nernst and his pupils' subsequent researches have furnished data that fill up some of the lacunæ that existed, and have shown that only within a limited range of temperature is this factor applicable.

A direct method of ascertaining the dissociation of water at high temperatures was devised by Leo Löwenstein, depending on the fact that glowing platinum acts as a semi-permeable membrane, permeable to hydrogen, impermeable to oxygen and water vapor. A closed platinum tube connected with a manometer was placed in an oven through which was passed a slow current of water vapor. The level of the oil in the manometer gradually altered until it became practically steady. From this alteration of level the partial pressure of the free hydrogen outside the platinum tube could be calculated. He thus found the percentage dissociation of water vapor at the following temperatures:

(1,432° + 273°) C.	0.102
(1,510° + 273°) C.	0.182
(1,590° + 273°) C.	0.354
(1,695° + 273°) C.	0.518

The results in Table I. were obtained, in the case of Nernst and Wartenberg, which experiments were at lower temperatures, by the streaming method, those of Wartenberg by the use of Löwenstein's method, viz., iridium semi-permeable membranes, and those of Irvine Langmuir by the catalytic action of a heated platinum wire, the temperature of which was ascertained by the change in its electrical resistance. In Nernst's experiments the lower temperatures were determined by thermo-electric methods and the higher ones by a Wanner optical pyrometer previously standardized by comparison with a thermo-electric junction. The temperatures found by this optical method Nernst and Wartenberg regard as probably correct within 10° or 15°.

TABLE I.—*The Dissociation of Water Vapor.*

Absolute Temperature. Degs. C.	Percentage of Dissociation of Water Vapor. x	As Observed by—	x as Calculated by W. Nernst.
1,000	....	.....	0.000030
1,100	....	.....	0.000182
1,300	0.0027	Irvine Langmuir	0.0029
1,397	0.0078	Nernst and Wartenberg	0.0084
1,480	0.0189	" " "	0.0185
1,500	0.0197	I. Langmuir	0.0221
1,561	0.034	Nernst and Wartenberg	0.0368
2,155	1.18	H. Wartenberg	1.18
2,257	1.77	" "	1.79

The calculated values are based upon thermodynamic date, namely, upon the specific heats of the gases concerned, their "heat of reaction," and the equation of the reaction isochore, and these are embodied in the following empirical equation:

$$\text{Log}\,\frac{2x^2}{\left(2+\frac{x}{100}\right)\left(1-\frac{x}{100}\right)^2} = 11.46 - \frac{25{,}030}{T} + 2.38\,\log.\frac{T}{1{,}000} - 1.38.10^{-4}\,(T-1{,}000) - 0.685.10^{-7}\,[T^2-(1{,}000)^2]$$

Professor Nernst claims a very satisfactory agreement between the values thus calculated and the experimental ones, the difference being no greater than may be explained by errors in the measurement of the temperatures.

Dissociation of Carbon Dioxide.—

TABLE II.—*The Dissociation of Carbon Dioxide.*

Temperature. Absolute. Degs. C.	Percentage of Dissociation.	As Observed by—	As Calculated by Nernst.	Ratio Per Cent. of Dissociation of H_2O to CO_2. Experimental.	Ratio Per Cent. of Dissociation of H_2O to CO_2. Calculated.
1,000°	....	.....	0.0000158	....	190.0
1,100°	....	.....	0.00020	....	91.0
1,300°	0.00419	Nernst and Wartenberg	0.0040	65.0	72.5
1,400°	0.0138?	" " "	0.0138	56.0	61.0
1,478°	0.029	" " "	0.032	59.0	57.8

Nernst, from experiments and extrapolations calculated from the thermodynamic data, finds that the dissociation of steam and carbon dioxide takes place at the various pressures and temperatures as in Table III.

TABLE III.—*Ratios of Dissociation.*

Absolute Centigrade Temperatures.	Dissociation of Water Vapor at the Pressure of, Atmospheres. 10	1	0.1	0.01	Dissociation of Carbon Dioxide at the Pressures of, Atmospheres. 10	1	0.1	0.01	Multiplier.	Ratio Per Cent. of A to B.
		A				B				
1,000	1.39 ×	3.00 ×	6.46 ×	13.9 ×	0.73 ×	1.58 ×	3.40 ×	7.31 ×	10^{-5}	190
1,500	1.03 ×	2.21 ×	4.76 ×	10.3 ×	1.88 ×	4.06 ×	8.72 +	1.8 ×	10^{-3}	55
2,000	0.273	0.588	1.16	2.70	0.818	1.77	3.73	7.83	unity	33
2,500	1.98	3.98	3.16	16.6	7.08	15.8	80.7	53.0	unity	25

Messrs. Jaquerod and Perrot have determined the co-efficient of expansion of gases at temperatures ranging from (0° + 273°) to (1,067.4 + 273°), the melting point of gold. They used thermometers constructed of silica and filled with various gases—namely, nitrogen, air, carbon dioxide, carbon monoxide and oxygen. It was found that neither hydrogen nor helium can be used in these instruments, as these gases diffuse through silica, commencing with hydrogen at (200° +273) and with helium at or below (100° +273°). Porcelrin theromometers filled with nitrogen were also found unreliable, by reason of diffusion of the gas through the walls of the tube. The results stated in order of magnitude were as follows:

Carbon monoxide	0.0036638
Nitrogen	0.0036640
Air	0.0036644
Oxygen	0.0036652
Carbon dioxide	0.0036756

Using their results to calculate vapor densities and thence molecular weights, they find values of the latter at 1,067° + 273° agreeing with those at the ordinary temperature. This shows, in particular, that carbon dioxide cannot be dissociated to so great an extent as 0.02 per cent. at 1,067° + 273°, in agreement with the observations of Nernst and Wartenberg, which show under 0.01 at atmospheric pressure.

The ratios between the dissociation of water vapor and carbon dioxide have been calculated from Nernst's data by the writer, and placed at the end of Tables II. and III., an inspection of which shows that at 1,000° absolute water vapor is dissociated 1.9 times as much as carbon dioxide, at 1,100° absolute, 0.91 times, at 1,500° absolute, 0.55 times, and at 2,500° absolute, only 0.25 times, all under the pressure of one atmosphere.

Action of H_2O and CO_2 upon Carbon.—Peder Farup has shown that the equivalence of dissociation at about 1,123° absolute, thus revealed, is the probable explanation of the equivalent rate of action of H_2O and CO_2 upon carbon. In his experiments the heating of carbon rods in a porcelain tube was electrical. The respective gases were passed through at a definite rate and afterwards collected and analyzed. Thus, under exactly corresponding conditions, CO_2 and H_2O react with carbon at 850° + 273° with a practical equal velocity, found to be the same as that which is attained by oxygen on carbon at a temperature lower by 400°, namely 450° + 273°. The temperature co-efficient of the latter reaction between 723° and 773° absolute has been determined, and from this the reaction velocity between oxygen and carbon at 1,123° absolute calculated. All the reactions being at atmospheric pressure, the rate of the latter is estimated as 3×10^6 times as great as that of the other two gases. At the temperature of Farup's experiments (850° + 273°) Nernst and Wartenberg's experiments show practically equal dissociation of water and carbon dioxide, or an equality of free oxygen therein by volume.

This concentration of oxygen is about $\frac{1}{0.7 \times 10^6}$ that of pure oxygen under the same conditions. In other words, pure oxygen has a concentration about 0.7×10^6 times as great as in the partially dissociated gases mentioned.

From these figures it appears that the reaction velocity in all three cases is approximately proportional to the oxygen concentration, and Farup suggests that it is the rate of reaction between carbon and oxygen which is being measured in each case. Further experiment is, however, required before this view of the connection between the phenomena can be regarded as established, and one consideration for a suspended judgment is the fact that the variation of reaction velocity with change of temperature has not yet been established over wide ranges. This point, so far as it concerns nitric oxide, has recently been investigated by K. Jellinek over the range 650° to 1,750°. He finds that the thermodynamic formula of van't Hoff, viz., $\log K = -\frac{A}{T} + B$ is unsatisfactory, and that a relationship $\log K = AT + B$ agrees better with the experimental determinations.

The dissociation of water vapor, as Helmholtz showed, can be calculated from the electro-motive force necessary for the reversible decomposition of water, but more precisely by the following method, given by Nernst and used by G. Preuner. Employing the ratios of the dissociation constants of the reactions represented by $2CO + O_2 \rightleftharpoons 2CO_2$, (K_1); $CO_2 + H_2 \rightleftharpoons CO + H_2O$, (K_2); he obtained the dissociation constant for $2H_2 + O_2 \rightleftharpoons 2H_2O$ $(K)_3$; namely, $K_1K^2_2 = K_3$, which, at 1,000° C. he calculated from Le Chatelier and Boudouard's experimental data to be 5.2×10^{-12}. By the aid of the temperature co-efficient for the heat of formation, the value at 20° is calculated as 5.7×10^{-78} and the electro-motive force for oxygen-hydrogen cell is found to be 1.15 volts, a number in close agreement with the actual value. Since G. Preuner, Nernst has made a calculation of the electro-motive force of the oxygen-hydrogen gas cell based upon his experimental work on the dissociation of H_2O and finds $\varepsilon = 1.232 - 0.00085\ (t - 17)$ volts, a value which he regards as probably correct to within a few millivolts.

Air Gas and Water Gas Reactions.—A knowledge of the temperatures at which dissociation of water vapor and carbon dioxide becomes large is of value in understanding the reactions which occur in air gas and water gas manufacture. Some years ago Messrs. Biedermann and Harvey, of the staff of Sir William Siemens, patented the use of "products of combustion" injected, along with air, into the gas producers used for the heating and melting of iron and steel, and this method was adopted at a number of furnaces, both in England and Scotland; it was also tried, to a limited extent, for the heating of gas works retorts. Quite recently, in America, the plan has been tried for the last-named purpose, and considerable advantage claimed in fuel economy and in reduction of labor in clinkering. In these practical operations the injection of a quota of the products of combustion at a high temperature takes the place of the ordinary injection of steam, either of which, for air, can only be substituted in limited quantity.

Some years ago A. Naumann showed that certain economic advantages were to be obtained (under well defined conditions of the employment of the gas made) by the addition of steam to air prior to passing through the fuel in the generator, and, also, that in this matter carbon dioxide had some superiority over steam, inasmuch as, although the heat abstraction from the fuel necessary for the decomposition of either gas was about the same, yet the endothermic action for the former could proceed at a lower temperature than was possible for the latter.

More recently, Hans von Jüptner has applied the principles of physical chemistry, especially Guldberg and Waage's law of equilibrium, to the reactions concerned in the production of water gas. He concludes that in order to obtain the best results in the action $H_2O + C = CO + H_2$, (1) the pressure must not be too high; (2) the temperature must not fall below 800°–900° C.; (3) with pressures up to four atmospheres the temperature should not exceed 900°–1,000° C. These conditions hold for the ideal state, viz., when there is equilibrium in the generator. If there be not equilibrium, the composition of the gas will alter on its way through the generator, and its final composition will depend on the height of the coke column, the velocity of the current of steam, and the temperature. It is of great practical importance to introduce the steam at the coldest part of the generator, so as to avoid the reaction, $2CO = C + CO_2$, in the cooler parts. If this action be allowed to take place, a deposit of carbon or "lampblack" will occur, the useful gas carbon monoxide will be lost, and the useless gas, carbon dioxide, will take its place, necessitating expense in purification.

This decomposition has been shown to occur in practice in a somewhat similar sphere of operations, F. Wurtenberger having found the decomposition of carbon monoxide with deposition of carbon in the regenerator of a Siemens-Martin steel furnace.

Action of Carbon Monoxide on Steam.—From Horstmann, in 1878, to the present time, many investigations have been made, including those of O. Hahn already referred to, into the temperature relations which determine whether the reaction $CO + H_2O \rightleftharpoons H_2 + CO_2$ shall proceed or preponderate in one direction or the other. Continuing this inquiry, Armand Gautier has recently studied the action of carbon monoxide on water vapor at a red heat, and similarly of hydrogen on carbon dioxide. He finds that carbon monoxide exerts a reducing action on steam at 1,200° + 273° to 1,250° + 273°, *i. e.*, carbon monoxide takes oxygen from the steam to form carbon dioxide, leaving hydrogen in the free state. The reaction is of the kind known as a balanced one, that is, it can proceed in the reverse direction by a change of temperature, and this takes place readily at 1,300° + 273° C.

At the first named range of temperatures equilibrium is reached when the volume of hydrogen produced is double that of the carbon monoxide present, as represented by the equation $3CO + 2H_2O = 2CO_2 + 2H_2 + CO$. At the second named temperature the reduction of carbon dioxide by hydrogen proceeds with the formation of carbon monoxide and water when the two dried gases are passed through a heated porcelain tube, and equilibrium is reached when the volume of CO_2 formed is half that of the hydrogen present, according to the equation $CO_2 + 3H_2 = CO + H_2O + 2H_2$.

From the two equations it would appear that between 1,200° + 273° and 1,300° + 273°, mixtures of hydrogen and the oxides of carbon are in equilibrium with steam when they are present in the molecular proportions represented by the system $CO + H_2O + 2H_2 + CO_2$, or in proportions by volume, carbon monoxide and water vapor each one-sixth and hydrogen and carbon dioxide each one-third.

The inverse operations to those of the dissociations of water vapor and carbon dioxide, namely, the union of hydrogen or carbon monoxide, respectively, with oxygen, have been studied by M. Bodenstein, assisted by Ohlmer. He has investigated more especially the effect of catalyzers upon these fundamental phenomena of ordinary combustion. He has observed that in the presence of compact platinum, oxygen and hydrogen unite at the ordinary temperature of the atmosphere with measurable velocity. He finds that the other combustion $2CO + O_2 = 2CO_2$ is catalytically accelerated when it takes place in a vessel of quartz glass.

The chief feature of the observations is the fact that CO retards its own combustion in the quartz glass vessel, so that the velocity of the reaction is almost inversely proportional to the concentration of the CO. This peculiarity is not observed when the reaction takes places in an ordinary glass vessel containing pieces of quartzite or rock crystal. With both these as catalyzers, the reaction velocity is directly proportional to the concentration of the CO_2 and proportional also, although only roughly, to the square root of the oxygen concentration. In all cases the temperature co-efficient for an interval of 10° was between 1.4 and 1.8.

Hans Kuhl had found previously that the velocity of this reaction at 570° + 273° C. could be determined by observing the gradual diminution of pressure accompanying the combination of the two gases and consequent diminution of volume. In his experiments the results obtained were somewhat irregular, for the velocity varied as one or other of the gases was first introduced into the vessel, which was of porcelain glazed internally. The initial velocity when dry oxygen is added to moist carbon monoxide is ten times as great as when moist CO is added to dry oxygen. Carbon dioxide was originally present in both these cases; but when CO_2 has not been previously introduced, the velocities in question are in the ratio of 2:1. The initial velocity is in general retarded by the presence originally of carbon dioxide; it is largely independent of the concentration of oxygen, but proportional to the first power of the concentration of carbon monoxide, whilst it increases with the amount of water vapor, but irregularly and to a less than proportional extent. It was found that when the reaction vessel had been previously exhausted the initial velocity was increased.

Kuhl, in endeavoring to explain the part played by aqueous vapor in the reaction, makes use of the theory set forth by Prof. Harold B. Dixon, viz., that the union of carbon monoxide and oxygen takes place in two stages (*a*) $CO + H_2O = CO_2 + H_2$; (*b*) $2H_2 + O_2 = 2H_2O$;

in which moisture acts as the intermediary. Assuming that the latter (*b*) takes place much more rapidly than the former (*a*), Kuhl deduces an expression which gives results that bear a strong although not complete resemblance to the experimental results.

Protection of Iron and Steel Against Corrosion by Painting.

Mr. George B. Heckel, in *Journal Franklin Institute*, says that the problem of protection by painting metallic surfaces comprises several important factors, differing materially from the conditions presented by a surface of wood. In the latter we have a more or less absorbent or porous surface, every minute aperture of which affords a hold for the film of paint. Furthermore, the coefficient of expansion for any wood under change of temperature is so low as to be negligible. If we can exclude moisture from the painted wood, the protective coating is subject to practically no stresses or strains.

Steel, on the other hand, presents to the eye an intact surface. It is only under magnification that we detect its actual irregularity. Two forces probably tend to hold a film of paint in place on such a surface: First, the hold of microscopic projections from the under surface of the film on the irregularities of the metal surface, and second, the force of cohesion or atmospheric pressure.

The coefficient of expansion for steel, within the limits of range for atmospheric temperature, is high—far higher than that of any known paint film. This deficiency in the latter must be compensated for by elasticity. The film must be sufficiently elastic to accommodate itself to the constantly changing area of the surface to which it clings, without rupturing the film itself or the minute projections by means of which it clings to the surface.

Finally, since moisture, acid, ozone and perhaps other atmospheric agencies are at least the principal causes of rust, the protective coating must, in so far as possible, be impermeable by vapors and gases.

From the stated difference of the two surfaces it is readily deduced that a paint to penetrate and secure a firm hold on the microscopic irregularities of a steel surface must be different from a paint intended to penetrate and adhere to wood, while the rigidity of the one as contrasted with the softness of the other would indicate other differences.

For example, Mr. R. S. Perry has propounded a very interesting theory, in which a parallel is drawn between the paint film and concrete, and from this he deduces the desirability of three determining sizes in the pigment particles to fill voids. But bearing in mind the extremely minute size of the projections and apertures, it would seem reasonable to assume that in the undercoating at least of a protective paint for such a surface the pigment particles should be extremely fine; and furthermore, as it is exclusively the vehicle and never the pigment that imparts elasticity to the coating, that the elastic vehicle should be in excess.

The Scientific Section of the Bureau of Promotion and Development, Paint Manufacturers' Association, under the direction of Mr. R. S. Perry, is doing very much valuable work in the way of furnishing technical data, and among other information it has furnished measurements of the particles of several pigments in common use. Following are the measurements given me:

White lead (hydrocarbonate)	.000074	.033
White lead (sublimed lead)	.00003	very uniform.
Zinc lead	.00004	"
Zinc oxide	.00002	"
Carbon black	.007	.0007
Lampblack	.00009	....
Mineral brown	.06	.007
Red lead	.006	.08
Silica	.00024	.0016
Calcium carbonate	.00012	.0016
Barytes	.00008	.0004
Gypsum (thin plates)	.00032	.0019
Asbestine (long rods)	.00016	.0032
China clay (thin plates)	.000016	.0028

These measurements represent the dry pigments as they come upon the market. With some of them chemical changes effected in combinations with oil acids profoundly modify these mechanical factors; with others, keeping in mind the conditions to be met, extremely fine grinding in the process of manufacturing into paint would seem to be indicated as essential.

Mr. Job, in a paper read before this body some two years since, admirably illustrated from practical experience the necessity of a high degree of comminution in protective paints for metal surfaces. The differences in the behavior of the paints contrasted by Mr. Job would seem to depend first upon the excess of vehicle (the elastic element) in paints compounded with finely ground pigments, and secondly in the smaller area of the voids between the particles of pigment in the paint film. For, as Dr. Dudley has so often and so admirably demonstrated, linseed oil is to a surprising extent permeable by moisture, and it is the province of the pigment, to a large extent, to compensate for this quality of linseed oil by presenting a series of impenetrable layers of pigment to the atmospheric vapors.

We now come, in the course of our review, to one of the most interesting developments of modern paint chemistry—a development which may eventually solve our problem, leaving nothing for future workers, or which may prove a mere *ignis fatuus* of science, like so many apparent discoveries which have preceded it.

During the year 1905, Dr. Allerton S. Cushman, of the Department of Agriculture, in the course of certain investigations connected with the corrosion of fence wire and steel culverts, made a special study of the curious fact that the corrosion of steel is inhibited for a time by treatment with chromic acid or a soluble chromate.

He has positively shown that chromic acid and its compounds will inhibit the corrosive action of moisture on iron. He has shown that iron passes into solution in pure water, and he has shown more recently that the mere presence of certain chromates, together with steel in water, inhibits oxidation.

The results obtained by Dr. Cushman in the latter field are summarized in a letter to me under date of March 11, as follows:

"I have been conducting a long series of experiments studying the action of various pigments together with water and oxygen on steel. I find that, under the conditions of my experiments, the ordinary commercial mixed pigments fall naturally into three classes:

"(1) Those which prohibit or largely inhibit corrosion.

"(2) Those which have no action one way or the other, and from this point of view are therefore inert.

"(3) Those which stimulate corrosion.

"I am not yet ready to give out the details of the experiments, but I will be very glad to give you one or two points which I should be pleased if you would bring out. My observation that chromic acid and certain of its compounds act as inhibitives has led to a great many experiments by other workers along the same line. Now, I have found that the chrome compounds which are on the market vary very much in their action. Some of them show up as strong inhibitors, while others go to the opposite extreme and actually stimulate corrosion. Referring only to the labeled names of the pigments which I have tried, I find among the good ones, and in the order cited: Zinc chromate, American vermilion, chrome yellow orange, chrome yellow, dd. Among the bad ones, and also in the order given, I find: Chrome yellow medium, chrome green, chrome red; and very much the worst of all is chrome yellow lemon.

"I presume that the difference is due to impurities that are present in the bad pigments. For instance, I believe that the lemon chrome yellow contains some salt or compound which had been added in order to keep the reaction acid during the process of manufacture so that the bright yellow shade will be preserved. You will understand, of course, that when I speak of 'good' and 'bad' pigments I mean merely in their relation to inhibiting or stimulating corrosion in the presence of water, and this characterization has nothing whatsoever to do with physical state or properties when mixed with oil. It is, however, important in my opinion that these differences should be noted in advance, for if an experimenter should happen upon lemon chrome yellow and obtain bad results with it he might unthinkingly conclude that the whole principle of the chrome protection was at fault."

In explanation of Dr. Cushman's results with the lemon chrome it should be said that this shade is commonly produced by the presence of lead citrate or other similar lead salts and that it is not a pure lead chromate.

What has been so far accomplished has been largely the result of empirical observation. This haphazard observation has, however, brought forward some significant data which it remains for the trained investigator to classify and from which he may gain an inkling of the basic governing principles.

Sabin, for example, long since demonstrated the fact that a coating of tough varnish applied hot to iron pipes prevents rusting in a

marked degree. Toch has pointed out the fact that steel rods imbedded for a long time in concrete showed little corrosion on removal. Several observers have proved that oxide of zinc, lampblack and some other very finely divided pigments under certain conditions are highly protective. The protective value of red lead freshly mixed before application has long been recognized. Scott, in an address before the Master Painters' Association of Wisconsin, stated that steel shutters painted for the J. I Case Company with basic lead chromate gave protection twice as long as any other material used, etc.

These and many more familiar instances would seem to indicate that we are at last in a position to lay down tentatively, at least, three conditions as necessary for the protection of steel from corrosion. We will briefly consider these conditions:

(1) *Isolation.*—The surface must be shielded as effectively as possible from the access of moisture and atmospheric agencies. This involves the necessity for a paint coating less permeable than linseed oil alone; sufficiently elastic to accommodate itself to the continual expansion and contraction of its support. This coating must furthermore be permanently adherent and must retain its elasticity during a reasonably long time. Fine grinding of the pigments used, the addition of China wood oil, varnish gums, and perhaps even a heavy neutral petroleum oil, used under proper conditions, may help us towards this end.

(2) *Insulation.*—If it be found—and it seems to be well established—that the passage of an electric current through the members of a steel structure, promotes corrosion, it is evidently a part of our task to reduce as far as possible this element of danger.

(3) *Immunization.*—This is to most investigators a new field with unknown possibilities. If it be found, as indicated in Dr. Cushman's experiments, that the mere presence of certain pigments in the paint film tends to retard corrosion, the converse is also probably true, that the presence of other pigments tends to facilitate it. After the investigators have finished their work of classification and have determined for us, in Dr. Cushman's phrase, which are the "good" and which are the "bad" pigments, it will remain for the paint technologist to apply the knowledge to practice. The pigments given in Dr. Cushman's list are all expensive, but it is probable that if there were any considerable demand for zinc chromate, for example, the price would soon fall to a moderate figure, due to increased production.

I was personally so much impressed with Dr. Cushman's original paper and with Mr. Scott's experimental confirmation following so soon after, that having occasion to supply a formula for a protective paint for use by the New Jersey Zinc Company, I suggested the following:

40 pounds American vermilion,
10 pounds red lead,
5 pounds Venetian red.

Zinc oxide and lampblack to produce the required tint or shade. Grind in 1½ gallons of raw linseed oil—increasing the quantity as required for added zinc oxide or lampblack—and ½ gallon crusher's dryer. For use, thin with raw oil and very little turpentine or benzine.

This is Scott's formula slightly modified. I am inclined to believe that the substitution of zinc chrome for the American vermilion; of any high grade, finely ground iron oxide for the Venetian red; and of American vermilion for the red lead, would improve the protective value of the formula, while I also believe that the addition of a very little kauri gum varnish, if zinc oxide is used, would be found advantageous, and that the substitution of a certain proportion of China wood oil for some of the linseed oil would improve the wearing qualities of the paint.

Dr. Cushman, in reviewing the formula, points out two dangers confronting us when we attempt to base an inhibitive formula on commercial products. The first is that all carbon pigments, excepting pure graphite, may contain sulphur compounds easily oxidizable to sulphuric acid when spread out as in a paint film. The second is the probability of variation in the composition of basic lead chromate or American vermilion. Because of these facts, as he points out, it is necessary, before selecting any particular pigment for its inhibitive quality, to ascertain that it is free from acids or acid forming impurities. As a result of his own experiments he recommends the substitution of Prussian blue for the lampblack in my formula and lays down as a safe rule in the formulation of inhibitive paints a careful avoidance of all potential stimulators of the hydrogen ions and consequently of any substance which might develop acid; preference being given to chromate pigments which are to some extent soluble in water and to other pigments which in undergoing change tend to develop an alkaline rather than an acid reaction. Calcium sulphate, for example, in any form (as a constituent of Venetian red, for example), he deems dangerous to use because of the possibility of its developing sulphuric or sulphurous acid. Barium sulphate, on the other hand, he regards as practically safe, because of its well known chemical stability.

In my own formula the substitution of zinc chrome for the larger proportion of American vermilion, as suggested, would replace an indefinite by a definite chromium compound.

Redivivus of the Baltimore Retort and Firebrick Company.

The business of the Baltimore Retort and Firebrick Company was started at Hull and Nicholson streets, Baltimore, Md., in 1868, by Mr. August Lambla, who moulded the first clay gas retort made in America. This business had a gradual, but steady growth and its products are well and favorably known, not only in the South, but also in other sections of the country, notably in the New England States, where Messrs. Waldo Bros., Boston, Mass., are the agents.

The above named plant was one of the three largest in the country and its facilities for making clay retorts, firebrick, fire tile, terra cotta chimney tops and vitrified clay specialties were unexcelled. The equipment permitted the manufacture and economical handling of shapes varying from one-sixth of an ounce to more than a ton in one piece.

Exceptional shipping facilities are enjoyed by this Company; in fact, such facilities as can be had only in a city with the material advantages of a location like that of Baltimore. Located on the river front, with the railroad running into the plant, enables it to obtain materials from and ship product to different localities most economically.

These receiving facilities are most important, for as there are no clays in any one section that are suitable for all purposes, the best results are obtained by mixing those from different localities in such proportions as only many years' experience can teach the most suitable for each.

The fire that destroyed the main building, containing the machinery, manufacturing departments and general offices of the Company, on the 17th ult., again demonstrated the energy and enterprise of the business men of Baltimore, and proved that the spirit that created a bigger and better Baltimore, from the ruins of the disastrous fire of February, 1904, has lost none of its force.

Within 24 hours offices were installed in a building opposite the ruins of the plant, and customers had received notice that orders for regular shapes would be filled from the stock which was uninjured; also, that kilns were in good condition, and arrangements would be made immediately to make and burn special shapes.

The customers responded splendidly, incidentally reducing that stock materially. That there was an unusually large stock on hand at that time was due to the Company's policy of not laying employees off because sales were below normal, thereby retaining the employees' loyalty by assuring them a regular income; and, in this case, showing a tangible profit by enabling the Company to satisfy its customers so well that not one of them has entered a word of complaint.

Within two weeks plans had been made and ground broken for the erection of a building comprising the most approved methods and equipment. This new building will be built in front of the kilns, being separated from them by a fire wall. The retort department will be a brick building with clear space from ground to roof to give plenty of head room and free circulation of air to facilitate drying.

Steel rails will be laid the length of this building, with a cross track at each end for switching purposes. Several other improvements in this department will increase the efficiency materially. Parallel to this will be a 2-story brick building, on the ground floor of which will be the grinding and mixing machinery, brick presses and dryers, so arranged that materials or goods in process of manufacture will always pass in the direction towards the kilns.

A system of elevators and conveyers will carry the prepared materials to the moulding rooms on the second floor of this building, which will be arranged so each operation will carry the goods towards the kilns.

The variety of shapes moulded in these rooms is unlimited, including plain and flanged rectangular tile, also irregular shaped tile;

arches and jambs for fire doors; tube tile and baffle-plates for water tube boilers, patent baker blocks, muffle and other parts for furnaces of every description using electricity, gas, oil or coal fuel.

A section of this department will be devoted to the moulding of the Company's patent tongue-and-groove arch lintels, for which there is a steadily increasing demand. They are tapered blocks of a size to form an arch 4½ inches thick, and of a width, proved by long experience, most economical to set when ability to withstand expansion and contraction is considered. Various lengths from 8 inches to 20 inches are carried in stock.

A tongue extends the full length, along one side, and a corresponding groove along the opposite one. These both strengthen the arch and break joints. The striking peculiarities of this construction are that no clay is required and the arch is entirely independent of the piers or jambs, which can be renewed or repaired without disturbing the arch. A steel structure will be erected to cover the kilns and a large space for storage of stock goods. A two-story brick building, with fireproof vault from ground to roof, will be erected at the southwest angle of the main building. General offices will occupy the first floor, where there will be an entrance to the lower deck of the vault, in which will be closets, shelves, etc., convenient for books, papers and other data pertaining to the accounting and sales departments.

The second floor will be for the exclusive use of the engineering and drafting departments. From this floor will be the entrance to the upper deck of the vault in which will be fixtures for the systematic filing of blue prints, sketches, descriptions, etc., of all shapes, both regular and special, made by them.

This Company designs and erects throughout the Eastern, Middle and Southern States coal gas benches, muffles, kilns and other appliances for confining or conducting extreme temperatures. The proposed method of safeguarding designs, many of which contain original features, will preclude the possibility of their loss in case of another visitation by the arch enemy of man's creations. Of most of those lost in the late fire there were duplicates, and sufficient data to replace the others will soon be compiled.

Mr. L. N. Rancke, Vice-President and General Manager, expects building will be completed and business adjusted to the new conditions by the end of this year, after which he will be pleased to have visitors call and inspect what is expected to be the most up-to-date firebrick plant in this country.

Items of Interest
FROM VARIOUS LOCALITIES.

AT the annual meeting of the Boston Consolidated Gas Company no change was made in the executive management.

THE Hutchinson (Kas.) Gas and Fuel Company has completed main extensions this season totalling 15 miles.

MR. H. R. COOK has assumed the duties of Manager of the gas division of the properties of the Wisconsin Railway and Light Company, with headquarters at Fond du Lac, Wis. He succeeded Mr. E. R. Whitcomb, who has removed to Milwaukee.

THE authorities have assented to an increase in the capital stock of the Stratford (Ont.) Gas Company. It was $75,000; it will be $150,000.

MR. R. M. WORDEN has resigned the position of Commercial Manager to the Augusta (Ga.) Gas Company. Strange-to-say, he has formed a partnership with the Banby Brothers in their amusement enterprises.

THE proprietors of the Bristol (Tenn.) Gas and Electric Company last December had agreed on certain plant improvements, the estimated cost of which was $50,000. The sharpness of the disordered conditions of the money market at that time was so acute, however, that the orders were not placed. Some days ago, at a special meeting to consider the situation, it was decided that the market conditions were such that the 1907 plan of reconstruction and enlargement should be at once taken up.

MR. M. E. SPRINGER, of Lincoln, Neb., has been awarded the franchise for the construction of a gas plant at North Platte, Neb. It is estimated that the necessary outfit will cost $50,000.

THE properties of the Leavenworth (Kas.) Light and Heat Company have been nominally transferred to the Leavenworth Light, Heating and Power Company, for the purpose of facilitating a mortgage rearrangement.

THIS story comes to us by way of El Paso, Tex., under date of the 14th inst.: "E. F. Weinhart, a lamp inspector of the El Paso Gas and Electric Company, has received word from the German Consul at St. Louis that he is an heir to $43,000 left him by Baron Engelbert Weinhart, of Munich, Bavaria. Mr. Weinhart lost no time in having the necessary papers of identification, etc., and left for St. Louis at once. He was at one time a line rider in the U. S. Custom's Service."

PROCEEDINGS have been instituted (at least so declares the Goshen *Republican*) to foreclose the mortgage underlying the bonds of the Port Jervis (N. Y.) Electric Light and Power and Gas Company. The papers were issued at the instance of the Knickerbocker Trust Company, which is plaintiff in the action by virtue of its capacity as Trustee. The sum involved is $450,000.

THE Easton (Pa.) Gas Company has been awarded a contract to supply the Nazareth (Pa.) Electric Light and Power Company with all the current the latter may require for lighting or other purposes. Work on the conducting lines will be completed by October 15th, if not before.

"W. B." writing from Washington, D. C., under date of the 11th inst., says that the Board of Commissioners, District of Columbia, urge upon Congress legislation compelling the gas companies to furnish gas for street lighting purposes at 65 cents per 1,000 cubic feet, is the recommendation included in the annual estimate for the next fiscal year as submitted by the Electrical Engineer for the District, Mr. W. C. Allen. Mr. Allen in his annual estimates says that, according to information furnished by the American Street Lighting Company, of Baltimore, the present contractors for mantle gas lighting, the cost of maintaining each lamp per annum is $20.85, of which sum $12 is for gas, the remainder going for maintenance, labor, repairing lamps and replacing lights. The contractors claim that at the present rate of $1 per 1,000 cubic feet for gas they are unable to make any money, and wherefore the prices asked for the coming year will undoubtedly be higher. The Engineer then recommends that the charge for each lamp be divided as follows: 12,000 cubic feet gas, at 65 cents per 1,000, $7.80; labor, $4.80; maintenance, $9.40. He then goes on to say: "There are a number of cities where contracts for this kind of service are awarded in two items, one for the gas and one for the maintenance. The figures noted for labor and maintenance amount to $14.20 per lamp per annum as a maximum price that can be paid under the law, if the price of gas is fixed as recommended. Where the city furnished the gas the prices for the service vary from $11.80 in Baltimore to $13.80 in Brooklyn." The Engineer, of course, could not foresee this happening, but the lamplighters in Brooklyn have been refusing to perform their duties under the existing rate of pay. Mr. Allen's estimate of the cost of his department for the next twelvemonth will be $496,745, as against the amount of $468,370 appropriated for the last year.

IN the ordinance under which it is proposed to construct and operate a gas works in Beaver Dam, Wis., *all* gas service pipes to be laid under the grant, "must be composed of standard size and weight of wrought iron."

WE are advised that the properties of the Marlboro-Hudson (Mass.) Gas Company have neither been absorbed nor offered for sale. In fact when appealed to the other day for information as to whether or not important negotiations looking to a transfer of the named properties, were pending, Mr. Charles W. Morse, the moving spirit in the enterprise, said: "The Marlboro-Hudson Gas Company is doing a nice business in the named settlements, and owns a fine manufacturing plant in Marlboro. The present Company took up the business in 1902, and has improved and extended it. We have established an excellent plant on a paying basis, and you can say that the business has not been bought and cannot be bought. The Company not only has not been absorbed by any association, but you can say positively that it will not be absorbed and that it will continue making and selling gas at the old stand. We want nothing to do with general associations of gas companies. The Marlboro-Hudson Company is owned by John, Michael and Daniel Cushman and myself. The Ames-

bury and Salisbury Company is controlled by about a dozen shareholders, among whom are John Cushman and myself. We also own stock in the Gainesville Company, but none of the other Marlboro-Hudson stockholders are interested in Amesbury, Salisbury or the Gainesville Companies. All three are separate Companies and separate ownerships, and the Marlboro-Hudson Company has no connection in a business way with the other two. As I understand it, we are supposed to have been absorbed by the Massachusetts Lighting Company."

THE gas engine plant that has for years been operated on natural gas by the Lippincott Glass Chimney Company, of Alexandria, Ind., is being remodelled to take producer gas as the fuel used.

HERE is the present standing (Sept. 18th) of the differences between the authorities of Buffalo, N. Y., and the Buffalo Gas Company, as forwarded by Mr. L. A. Veith: "Following the action of the Councilmen the afternoon of the 10th inst., in approving the stand taken by the Aldermen to pay the Buffalo Gas Company not more than 75 cents per 1,000 cubic feet of gas furnished to the city, Assistant Corporation Counsel, W. B. Frye, secured from Justice Brown an injunction which forbids the Company from shutting off the city's supply of gas as the Company declared it would do on the 10th inst., unless the 95-cent rate should be paid. In connection with the injunction the city served on the Vice-President (R. L. Fryer) of the Company summons and complaint in an action to determine the reasonable value of the gas used by the city since July 1, 1907, and to compel the Buffalo Gas Company to accept this price for back and future bills. The Company must answer this summons and complaint within 20 days unless in the meantime an order vacating the temporary injunction is secured. Corporation Counsel Desbecker and Mr. Frye were busy preparing the papers in the case while the Councilmen were debating the matter. Councilman Bull wanted the subject referred to a committee of two. His motion to that effect was lost on a tie vote, and the Councilmen then voted to concur in the action of the Aldermen. When Mr. Desbecker was informed of this action, he at once went before Justice Brown, who issued the following injunction, upon the affidavit of Mr. Frye: "*Ordered*, That the defendant, its officers and servants and agents be, and they are hereby, enjoined and restrained from discontinuing or shutting off the supply of gas to said city, as now and heretofore supplied, during the pendence of this action and until the further order of the court, and the said defendant is hereby required and commanded to supply such gas until the further order of this court." There the matter rests.

IT is asserted that the plant of the Iron Mountain (Mich.) Gas and Fuel Company will be in active work the first inst. It is likely that November 1st will be nearer to the mark.

THE following figures are from the Fourth Annual Report of the Board of Gas and Electric Commissioners of Norwich, Conn., to the City Council—these plants are operated on municipal account: The net profit for the year, as shown by the schedules, was $26,986.15, after charging off $14,250.38 (which sum represents 5 per cent. of the investment, July 31, 1907) for plant depreciation. It thus appears that the income for the year exceeded the cost of manufacture and distribution by $41,236.52. The salaried officers and the pay thereof are: Commissioner and Acting Superintendent, $1,500; clerk and cashier, $1,200. The number of arc lights now in use on public account is 235, the incandescents numbering 294. The lights burn all night and every night. The cost to the city for lighting the public streets and public buildings, including care of lamps, during the twelvemonth—ended June 30th last—was $23,858.43. The cost of lighting the public buildings was: For gas, $99.90; electricity, $994.40, or a total of $1,094.30. The cost of street lighting was $22,764.13, of which amount $18,690.13 was for arc electric lights, and $4,073.60 was for incandescent electric lights. The actual cost to the city, therefore, for each arc light, was $79.53 per annum; $13.85 for each incandescent lamp. The street arc lighting service has been improved by the operating of the lights on 5 currents instead of 4, as heretofore. In the gas division of the property consumers the net difference between meters "out" and "in," shows a gain of 140. The gas meters in use now total 2,227. The electrical consumers number 1,037. The gain in gas sendout figured out at 11.29 per cent. for the year, and the gain in electrical sendout was a trifle over 10. The Commissioners recommend that a sensible cut in the rate charged for electric current be made. It is also strongly urged that the main system on gas account be largely extended.

SOME evenings ago the Mayor of Salem, Ore. (George F. Rodgers) discharged a shot that, although it may have been a random one, certainly caused the City Council to take notice. It also appealed, and naturally too, sharply to the ears of others. The Mayor, without note of premonition, handed in a special message declaring that the rates charged by the Salem Gas Light Company were excessive. The Salem Gas Light Company has for some time been a part of the possessions of the Portland Railway, Light and Power Company. The rate in Salem is $2 per 1,000 cubic feet, and the output of the Company is between 12 and 13 millions cubic feet, and the cost of materials entering into the manufacturing of gas, with the charge for labor as well, is about twice what that cost would be, say in the central part of New York—perhaps this statement would not apply to the cost of enriching oils. On the face of it, the rate may seem high, but the fuel conditions in that part of Oregon are such as to cause high prices therefor; but, whether so or not, one section of the Mayor's reasons for asking a reduction in the Salem rate is so wide of the mark that we fear it vitiates the virtue of it all. He declares that the average rate for gas in cities of the nature of Salem throughout the United States is $1 per 1,000 cubic feet. Not so, Mr. Mayor, the average is at least $1.50.

A CORRESPONDENT in La Porte, Ind., forwards this: "As stated in the report of Mr. R. A. Kinney, State Natural Gas Inspector for Indiana, in 26 counties of that State natural gas is being freely produced, and that in a number of these counties natural gas is the most common and generally used fuel for domestic purposes. Mr. Kinney's report, which goes into great detail in discussing the natural gas industry, is to form a part of the annual report of the State Inspector, Mr. W. D. Blatchley, State Geologist. The average price of natural gas in Indiana is 30 cents per 1,000 cubic feet and the daily flow is 20 millions cubic feet, or an average retail selling value of $6,000 per day. The supply, too, is admittedly far below the demands of users. Speaking of new producing fuels in Indiana, Mr. Kinney says that the operations in the Princeton field, Gibson county, show it to be a field of much importance. Considerable drilling is being done by the prospectors—mainly, though, on behalf of the Ohio Oil Company. Each completed well shows a fair flow of gas, and no well so far drilled has failed to furnish enough gas for fuel for the boilers of the oil operators. Sullivan and Vigo counties also promise to become good gas producing territory. According to the report this region is known as the Sullivan field. Several wells have been developed there which produce 1,000,000 cubic feet per day. Gas is plentiful and the city of Sullivan is now being piped. In Madison county, in what is known as the old field, great improvement in production has been noted this year. In Decatur county there is an excellent flow of gas and farmers are sharing in the privilege of the cheap fuel. "It is a rare sight," writes the Inspector, "to see a wood or coal stove in the county. In many localities every well-to-do farmer has his own gas well, from which he uses gas for heat and light for his house and outbuildings, as well as power for a gas engine. He then supplies the needs of his neighbors, who are small farmers or tenants. * * * There are no especially strong wells here, but the flow is strong and steady from all of them. * * * Decatur county has never been considered in the 'gas belt,' but her people have enjoyed the use of gas necessary for domestic use since the first discovery of gas in Indiana." The greatest part of the gas supply in Decatur county, it is stated, comes from the Trenton rock at a depth of from 800 to 1,000 feet. The report pays much attention to the question of the plugging of gas wells. Many of the operators realize the importance of husbanding the gas supply, and have observed the law which requires that gas wells shall be properly stopped or plugged before the casing is drawn. Some of the most common violators of this law, though, are the junk dealers who buy the old iron and casing from the defunct gas and oil wells and leave them without any attention whatever. The land owners then disclaim any responsibility for the plugging of the wells. The junk men do likewise, and it is difficult to locate the responsible person. Failure properly to plug a gas well produces an injurious effect on the gas bearing rocks for many miles around and affects good producing wells great distances from where the mischief was done. Pumping stations which are designed to reinforce the natural rock pressure by pumping the wells have been the means of exhausting the gas supply years earlier than would have resulted had the natural pressure been depended upon, says the report. It is stated, however, that nearly all of these pumping stations have been abandoned and that conditions have greatly improved as a result of this.

THE AMERICAN GAS LIGHT JOURNAL

The Market for Gas Securities.

The market for city gas shares was decidedly of the eccentric order during the week. Consolidated sold early in the period at virtually 152, and down to-day (Friday) at noon to 145, which figure was bid at the hour noted. Realizing and the squeezing out of a certain short interest account for the decline. Intrinsically values in it are constantly making for the holder.

Brooklyn Union also shared in the erratic movement, but there was financial reason for the pyrotechnics shown. On the 12th inst. a dividend of 3 per cent. was declared on the stock, which was ½ per cent. advance over the dividend last March. As dividends are hereafter to be declared on it semi-annually the shares would seem to be on a 6 per cent. basis. The stock is quoted at 138 to 145. The United Gas Improvement Co.'s dividend of 2 per cent. for the quarter is payable the 15th prox.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

SEPTEMBER 21.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid*	*Asked.*
Consolidated Gas Co.	$73,177,000	100	145	145⅛
Central Union Gas Co.—				
1st 5's, due 1928, J. & J.	3,000,000	1,000	93	93¼
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	—	105
Mutual Gas Co.	3,500,000	100	130	160
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	92	96
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	—	98	104
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	100	105
Con. 5's, due 1945, J. & J.	1,500,000	—	97	101
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	90	98
Standard	5,000,000	100	70	100
Preferred	5,000,000	100	100	125
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	100	105
The Brooklyn Union	15,000,000	1,000	138	145
1st Con. 5's, due 1948, M. & N.	15,000,000	—	91½	92
Yonkers	299,650	500	130	—
Out-of-Town Companies.				
Bay State	50,000,000	50	2⅛	2¼
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	65
" 1st Mtg. 5's	509,000	1,000	95	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
" " Bonds, 5's	5,250,000	1,000	63	66
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed Gold Bonds	7,660,000	1,000	104	106¼
Cincinnati Gas and Electric Co.	29,500,000	100	90	90½ x
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	92	98
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	90¼	91
Preferred	3,026,500	100	71	80
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	—	105
Mortgages, 6's	3,600,000	—	—	118
Chesapeake, 1st 6's	1,000,000	—	—	—
Equitable, 1st 6's	910,000	—	—	—
Consolidated, 1st 5's	1,490,000	—	—	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	—	—	100
Denver Gas and Electric	—	—	74¼	75
Detroit City Gas Co	6,000,000	50	—	50
" Prior Lien 5's	4,618,000	1,000	—	98
Detroit Gas Co., 5's	381,000	1,000	75	80
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	39	40
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Light Co., 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	100	105
" Bonds, 5's	10,500,000	—	101	102½
Indianapolis	2,000,000	—	60	70
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede Gas Co., St. Louis	10,000,000	100	—	100
Preferred	2,500,000	100	80	90
Bonds	10,000,000	1,000	104	104¼
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas and Electric Co.				
" 1st Mtg. 6's	350,000	1,000	108	108¾
" 6 per cent. scrip, due 1910	100,000	25	60	60½
Massachusetts Gas Companies, of Boston	25,000,000	100	56¼	56¾
Preferred	25,000,000	100	86	86¼
Montreal Gas Co., Canada	2,000,000	100	218	218¾
Nashville Gas Light Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	56	58
Bonds, 6's	5,000,000	—	137	138
New Haven Gas Co.	2,000,000	25	200	—
Peoples Gas Lt. & Coke Co., Chicago	25,000,000	100	95	95½
1st Mortgage	20,100,000	1,000	—	—
2d "	2,500,000	1,000	104	—
Rochester Gas & Electric Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104¼	105½
San Francisco Gas Co., Cal.	15,500,000	—	—	—
St. Joseph Gas Co.—				
1st Mtg. 5's	751,000	1,000	92	—
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgages, 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	96¼	—
Syracuse Gas Co., N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	102	—
Washington (D. C.) Gas Co.	2,600,000	20	320	330
1st Mortgage, 6's	600,000	—	—	—
Western Gas Co., Milwaukee	4,000,000	—	—	—
Wilmington (Del.) Gas Co.	600,000	50	230	—

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DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO.,
N. W. CORNER BROAD AND ARCH STS.,
PHILADELPHIA, PA., Sept. 9, 1908.

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable Oct. 15th, 1908, to stockholders of record at the close of business, Sept. 30, 1908. Checks will be mailed.

1736-5 LEWIS LILLIE, Treasurer.

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As Manager or Superintendent,

By competent gas man, 35 years of age, married, strictly sober, with operating experience both as manager and superintendent in actual charge of plants. A man who can show and give results; 17 years' experience; now acting as manager of coal gas plant in city of 15,000. Will have to give present people 60 days' notice. Address,

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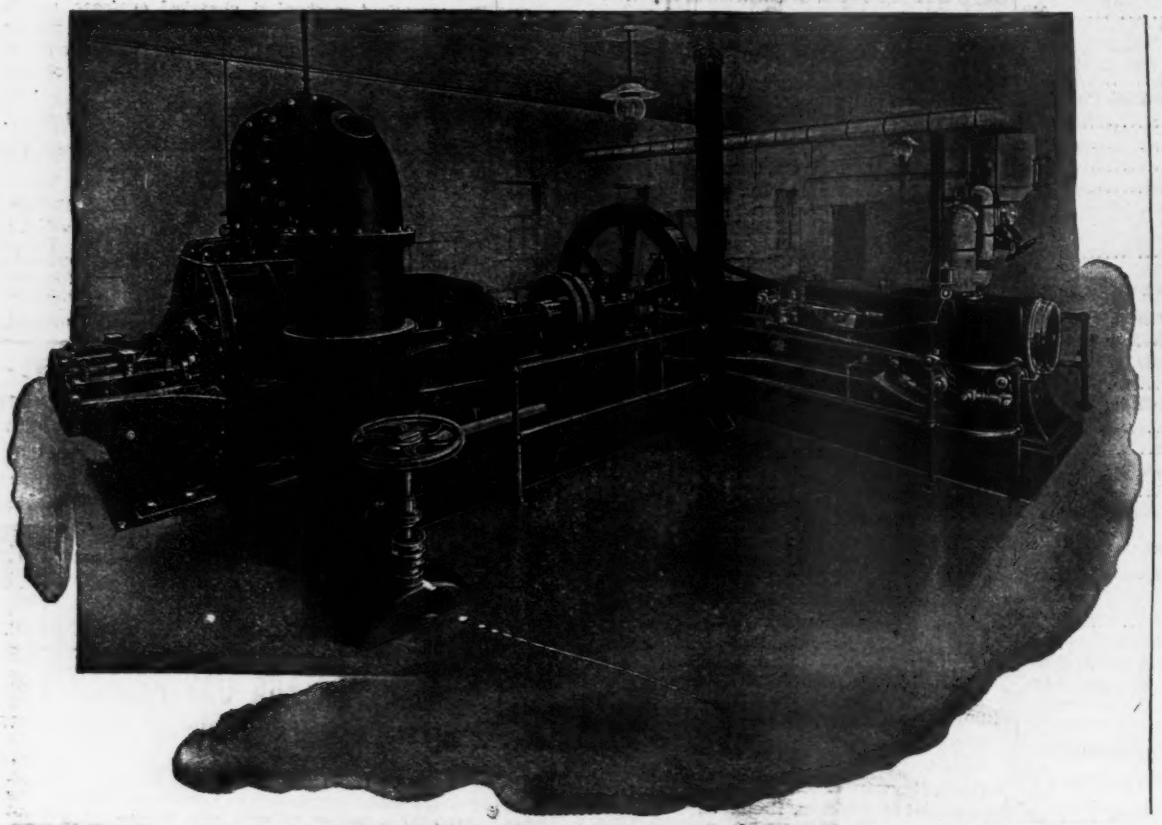

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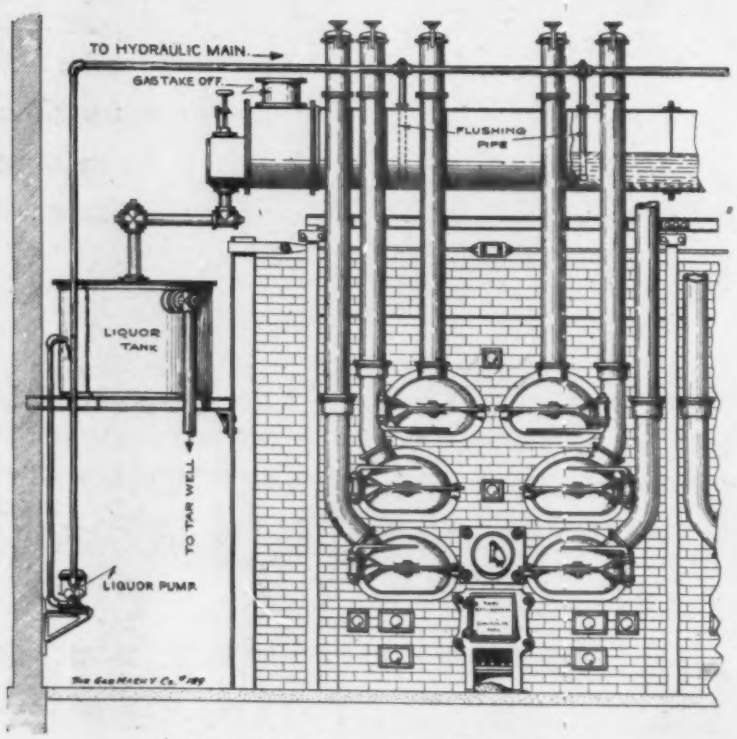

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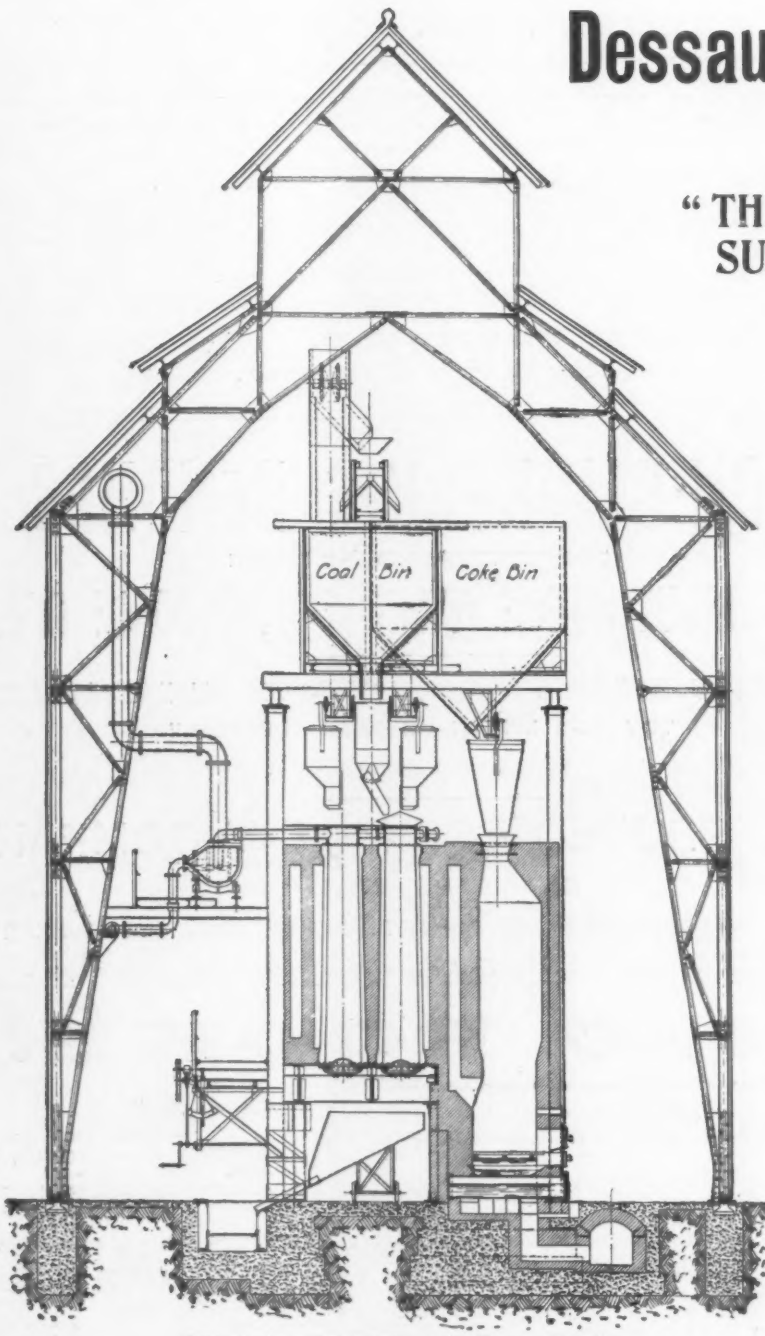

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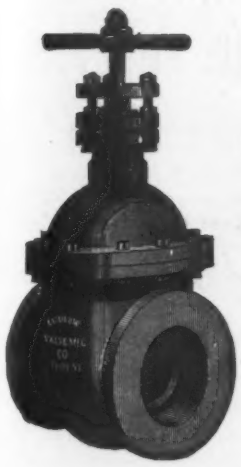

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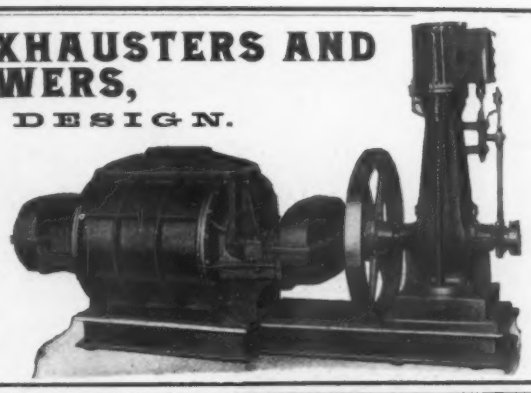

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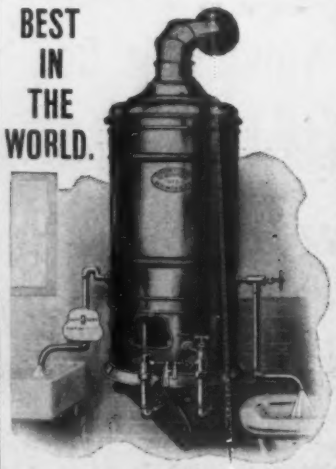

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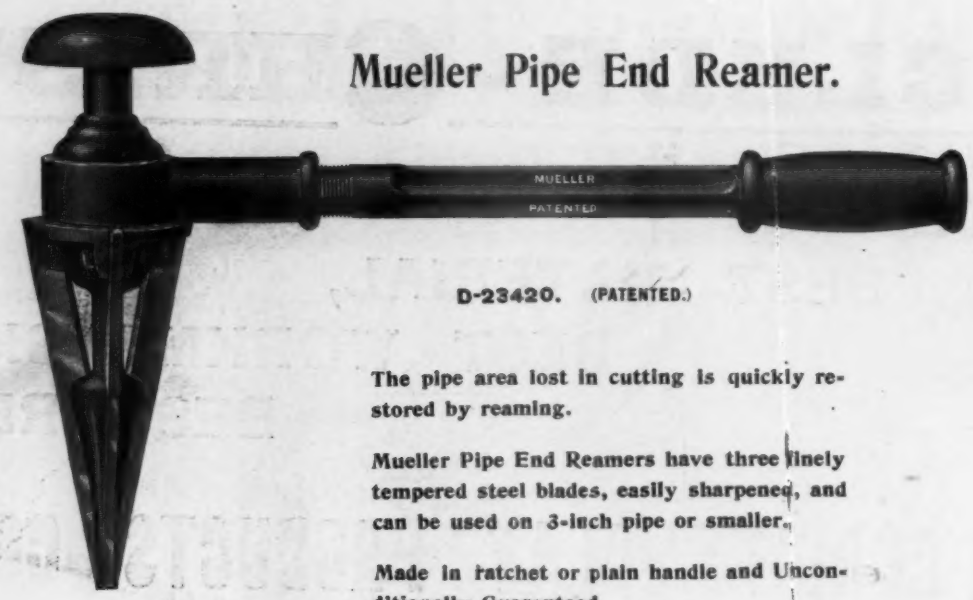

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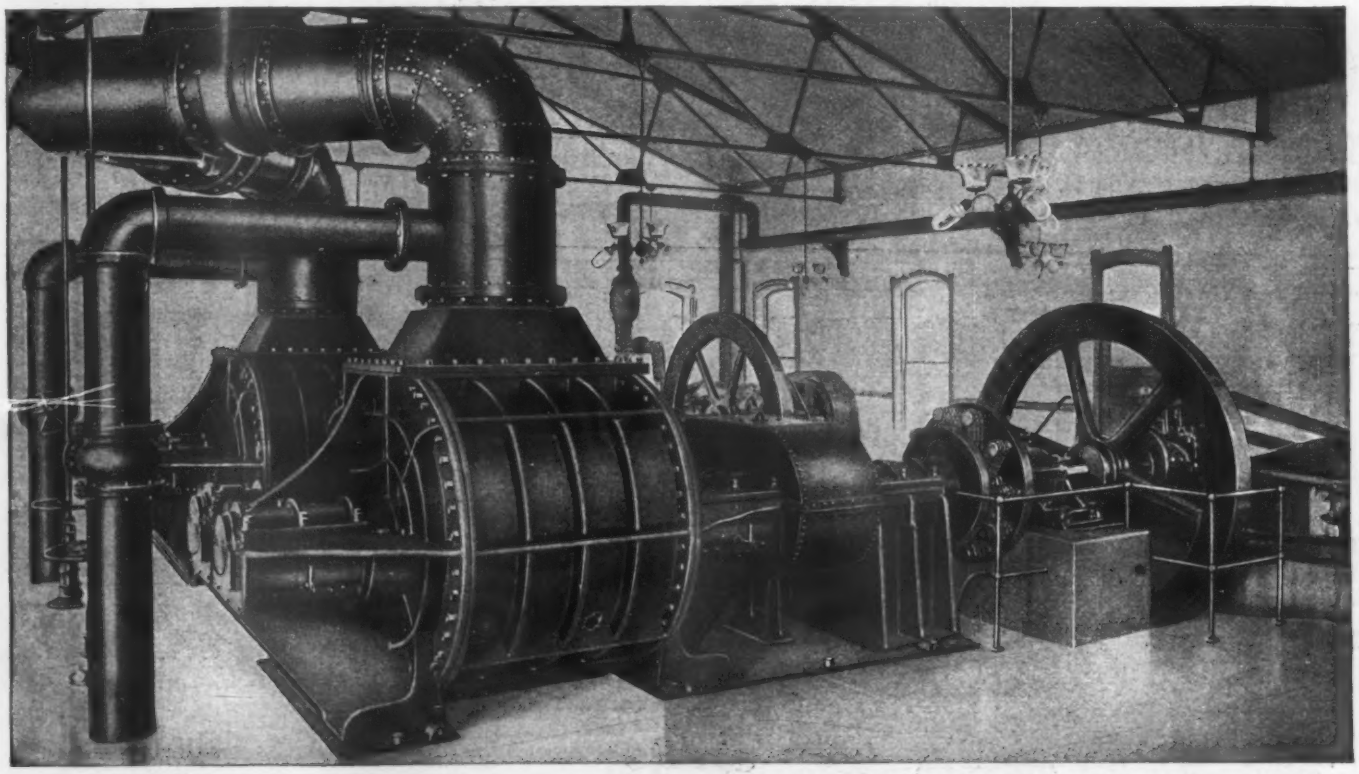

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PATENT SMOKED CHART RECORDERS.

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Photometrical and Experimental Apparatus.

PUBLIC LIGHTING TABLE.

OCTOBER, 1908.

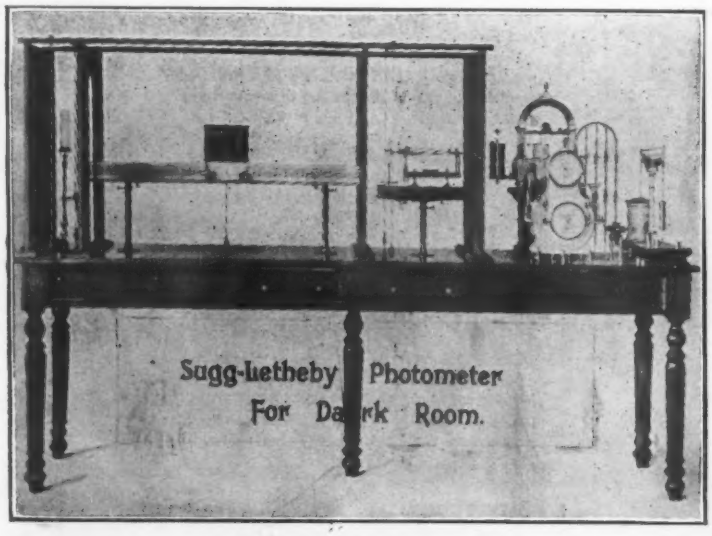
Table No. 1.
FOLLOWING THE MOON.

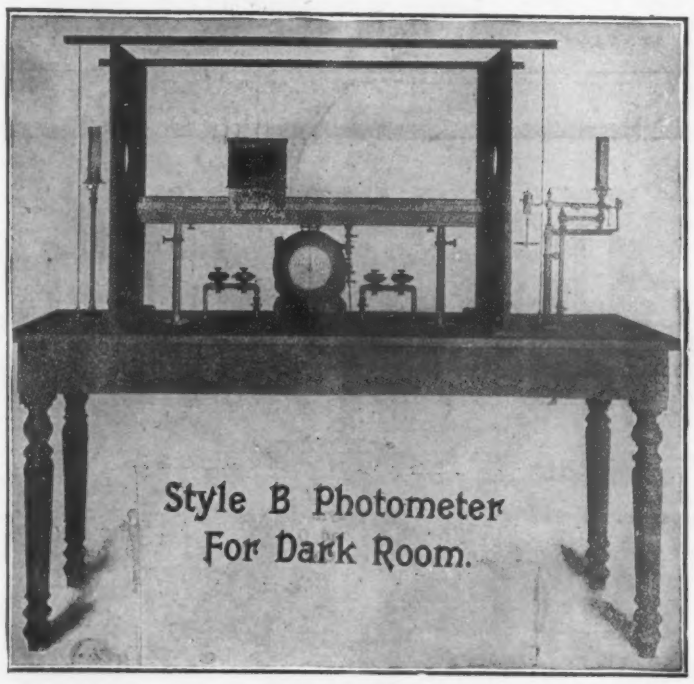
Day of Week.	Date.	Light.	Extinguish.
Thu.	1	8.30 PM	4.50 AM
Fri.	2	9.20 FQ	4.50
Sat.	3	10.20	4.50
Sun.	4	11.30	5.00
Mon.	5	12.40 AM	5.00
Tue.	6	2.00	5.00
Wed.	7	3.10	5.00
Thu.	8	No L.	No L.
Fri.	9	No L. FM	No L.
Sat.	10	No L.	No L.
Sun.	11	5.50 PM	7.50 PM
Mon.	12	5.50	8.30
Tue.	13	5.50	9.10
Wed.	14	5.50	9.50
Thu.	15	5.50	10.40
Fri.	16	5.50 LQ	11.40
Sat.	17	5.50	12.30 AM
Sun.	18	5.40	1.30
Mon.	19	5.40	2.30
Tue.	20	5.40	3.30
Wed.	21	5.40	5.20
Thu.	22	5.40	5.20
Fri.	23	5.40	5.20
Sat.	24	5.40 NM	5.20
Sun.	25	5.30	5.20
Mon.	26	5.30	5.20
Tue.	27	5.30	5.20
Wed.	28	5.30	5.20
Thu.	29	7.20	5.20
Fri.	30	8.10	5.20
Sat.	31	9.20	5.20

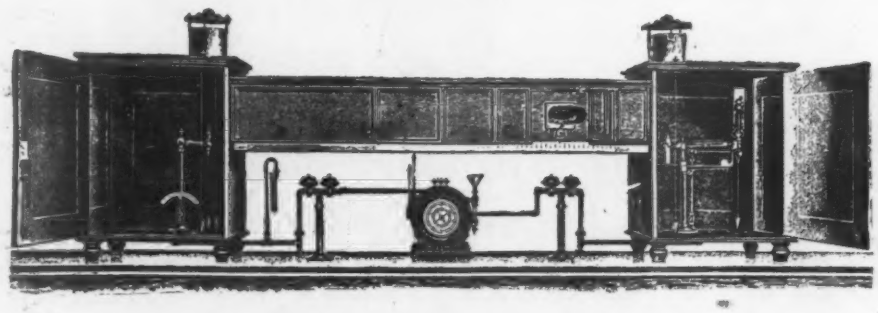
TOTAL HOURS DURING 1908.

By Table No. 1.

	Hrs.Min.
January	228.30
February	187.30
March	192.00
April	160.10
May	155.10
June	138.00
July	155.50
August	173.40
September	185.20
October	214.00
November	218.10
December	226.40
Total, yr.	2235.00







Closed Photometer For Light Room.

CIRCULARS SENT ON REQUEST.

PUBLIC LIGHTING TABLE.

OCTOBER, 1908.

Table No. 2.
NEW YORK CITY.
ALL NIGHT LIGHTING.

Day of Week.	Date.	Complete Lighting in One Hour	Complete Extinguishing in 50 Minutes
		From Time Given	
		P. M.	A.M.
Thu.	1	5.22	4.42
Fri.	2	5.22	4.42
Sat.	3	5.22	4.42
Sun.	4	5.22	4.42
Mon.	5	5.22	4.42
Tue.	6	5.22	4.42
Wed.	7	5.22	4.42
Thu.	8	5.12	4.52
Fri.	9	5.12	4.52
Sat.	10	5.12	4.52
Sun.	11	5.12	4.52
Mon.	12	5.12	4.52
Tue.	13	5.07	4.52
Wed.	14	5.07	4.52
Thu.	15	4.57	5.02
Fri.	16	4.57	5.02
Sat.	17	4.57	5.02
Sun.	18	4.57	5.02
Mon.	19	4.57	5.02
Tue.	20	4.57	5.02
Wed.	21	4.57	5.02
Thu.	22	4.47	5.07
Fri	23	4.47	5.07
Sat.	24	4.47	5.07
Sun.	25	4.47	5.07
Mon.	26	4.47	5.07
Tue.	27	4.47	5.07
Wed.	28	4.47	5.07
Thu.	29	4.37	5.17
Fri.	30	4.37	5.17
Sat.	31	4.37	5.17

TOTAL HOURS DURING 1908.

	Hrs.Min.
January	481.50
February	329.15
March	351.50
April	341.50
May	233.05
June	218.10
July	282.55
August	254.55
September	292.25
October	420.45
November	374.30
December	411.05
	3992.35
Deduct on account of 50 min. extinguishing time	30.30
Total, yr.	3962.05

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Everett, Mass.
Jenkintown, Pa. (2d contract).
Coney Island, N. Y.
Mexico, Mo.
Jacksonville, Fla.
Syracuse, N. Y. (2d contract).
Atlanta, Ga. (2d contract).
Holyoke, Mass.
Peoria, Ills.
Schenectady, N. Y. (2d contract).
Danbury, Conn.
Galveston, Tex. (2d contract).
Quebec, Canada.
Indianapolis, Ind. (2d contract).
Bessemer, Ala.
Waterbury, Conn. (5th contract).
Sioux Falls, S. D. (3d contract).
Philadelphia, Pa.
New Hartford, Conn.
Poughkeepsie, N.Y. (2d contract).
Nashville, Tenn.
Salisbury, Md.
Norfolk, Va. (4th contract).
Wallingford, Conn.
Richmond, Va. (2d contract).
Oak Bluffs, Mass.
Arlington, Mass.

TOTAL SETS INSTALLED DURING YEAR, ... 43
TOTAL SETS INSTALLED TO DECEMBER 31, 1907, ... 677
TOTAL DAILY CAPACITY, TO DECEMBER 31, 1907, ... 545,865,000 cu. ft.

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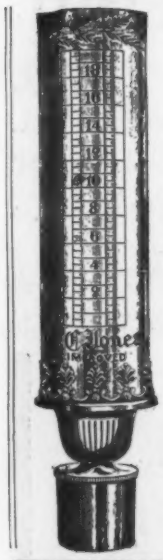

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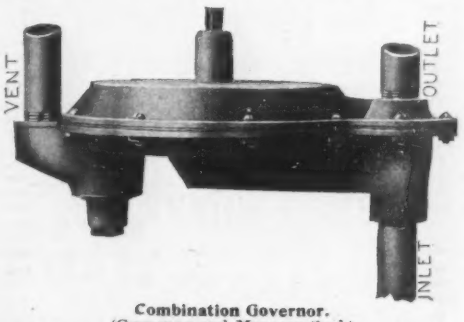

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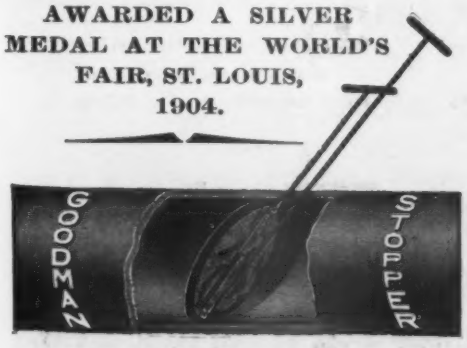

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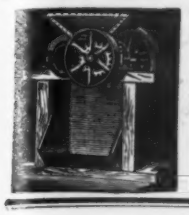

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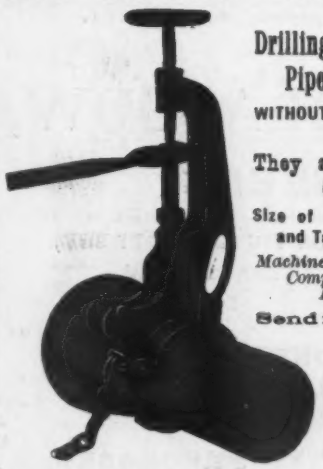

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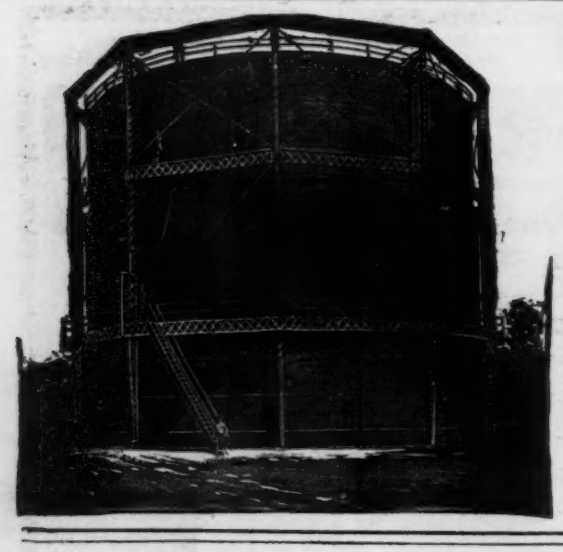

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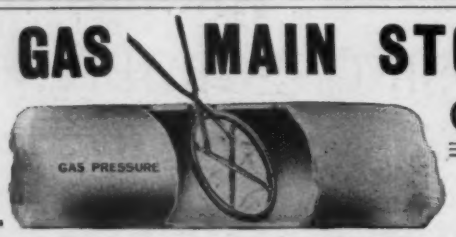

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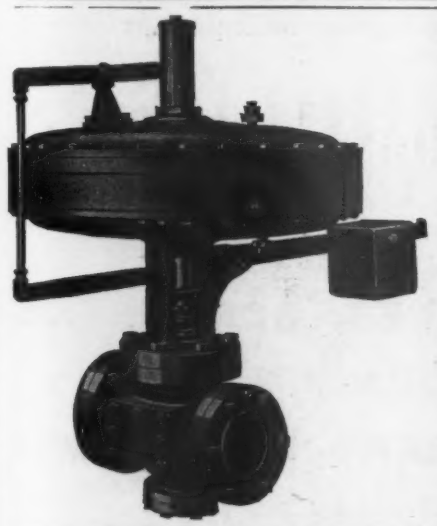

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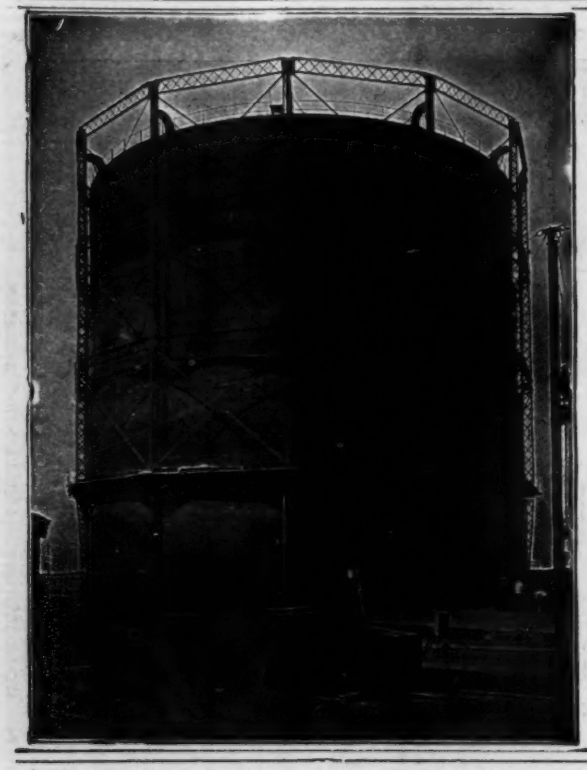

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